105th Congress, 2d Session – – – – – – – – – – – – House Document 105–352

A FLOOD DAMAGE REDUCTION PROJECT FOR RIO NIGUA AT SALINAS, PUERTO RICO

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, THE DEPARTMENT OF THE ARMY

TRANSMITTING

A RECOMMENDATION BY THE SECRETARY OF THE ARMY TO AUTHORIZE A FLOOD DAMAGE REDUCTION PROJECT FOR RIO NIGUA AT SALINAS, PUERTO RICO

DECEMBER 18, 1998.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

105th Congress, 2d Session – – – – – – – – – – – – House Document 105–352

A FLOOD DAMAGE REDUCTION PROJECT FOR RIO NIGUA AT SALINAS, PUERTO RICO

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, THE DEPARTMENT OF THE ARMY

TRANSMITTING

A RECOMMENDATION BY THE SECRETARY OF THE ARMY TO AUTHORIZE A FLOOD DAMAGE REDUCTION PROJECT FOR RIO NIGUA AT SALINAS, PUERTO RICO

December 18, 1998.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

---

U.S. GOVERNMENT PRINTING OFFICE

52–958 WASHINGTON : 1999

CONTENTS

List of Tables

List of Figures

List of Plates

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

REPLY TO ATTENTION OF

07 AUG 1998

Honorable Newt Gingrich
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

In final response to a resolution adopted by the House Committee on Public Works and Transportation on October 1, 1986, the Secretary of the Army recommends authorization of a flood damage reduction project for Rio Nigua at Salinas, Puerto Rico. The proposal is described in the April 15, 1997, report of the Chief of Engineers which includes other pertinent reports and comments. The views of the Commonwealth of Puerto Rico, the Department of the Interior, and the Environmental Protection Agency are set forth in the enclosed report.

The recommended plan maximizes net national economic development benefits consistent with environmental quality. The plan consists of two separable elements. The first separable element consists of an earthen levee, about 2.96-kilometers (1.84-miles) long, which would provide flood protection to the communities of Salinas and Playa de Salinas located along the east bank of the Rio Nigua between Puerto Rico Highway 52 and the mouth of the river. Levee heights would range from about 1.5 meters (5 feet) to about 5 meters (16.4 feet). A Gabion rock mattress would protect the levee face and channel bank from erosion. The bridge and roadway ramp at Puerto Rico Highway 1 would be replaced and an existing railroad bridge, which is no longer in use, would be removed. The first cost of the Salinas separable element is estimated at $10,236,000.

The second separable element consists of an earthen levee, about 3.98-kilometers (2.47-miles) long, which would provide flood protection to the community of Coco located along the west bank of the Rio Nigua upstream of Puerto Rico Highway 52, and about 4 kilometers (2.5 miles) north of Salinas. The height of the levee would average about 3.8 meters (12.5 feet), and would be protected from erosion by the establishment and maintenance of a grass cover. The first cost of the Coco separable element is estimated at $3,100,000.

Both levees are designed to protect against a flood that has an expected annual exceedance probability of about 1 percent, or a 100-year flood. For the Salinas and Playa de Salinas area, the levee is expected to have about a 99 percent probability of containing the 100-year flood. For the Coco area, the levee is expected to have about a 91 percent probability of containing the 100-year flood. Overall, flood damages would be reduced by about 98 percent. Each of the separable elements is economically justified and represents the national economic development plan for that element. No separable fish and wildlife mitigation measures are required.

In accordance with Section 202(a) of the Water Resources Development Act of 1996, the minimum non-Federal costs for the flood damage reduction project would be 35 percent. Based on October 1997 price levels, the project has a total first cost of about $13,336,000, of which about $7,427,000 would be Federal and about $5,909,000 would be non-Federal. In addition, non-Federal interest would be required to implement a floodplain management plan for the project area. The project sponsor is the Puerto Rico Department of Natural and Environmental Resources.

The Office of Management and Budget advises that there is no objection to the submission of the report to the Congress. A copy of its letter is enclosed in the report.

Sincerely,

Joseph W. Westphal
Assistant Secretary of the Army
(Civil Works)

Enclosure

COMMENTS OF THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

APR 2 1 1998

The Honorable John H. Zirschky
Acting Assistant Secretary of the
Army for Civil Works
Pentagon - Room 2E570
Washington, D.C. 20310-0108

Dear Dr. Zirschky:

As required by Executive Order 12322, the Office of Management and Budget has completed its review of your recommendation for the Rio Nigua at Salinas, Puerto Rico, project.

The Administration supports authorization of this project for construction in accordance with the recommendation of your letter of July 9, 1997. The Office of Management and Budget does not object to submission of this report to Congress.

Sincerely,

Kathleen Peroff
Deputy Associate Director
Energy and Science

COMMENTS OF THE COMMONWEALTH OF PUERTO RICO

COMMONWEALTH OF PUERTO RICO
OFFICE OF THE GOVERNOR
PUERTO RICO PLANNING BOARD

Minillas Governmental Center, North Bldg.
De Diego Ave. Stop 22
P. O. Box 41119, San Juan, P. R. 00940 - 1119

January 21, 1997

Mr. David B. Sanford, Jr.
Chief, Policy Division
Policy Review Branch
Directorate of Civil Works
U.S. Army Corps of Engineeers
Washington, D.C. 20314- 1000

Dear Mr. Sanford:

Reference is made to letter dated November 20, 1996 requesting comments on the document Final Feasibility Report and Environmental Assessment for Rio Nigua at the Municipality of Salinas.

Enclosed, herewith, copy of our comments to Ms. Ada Squires, Policy Review Branch, dated December 31, 1996.

Do not hesitate to contact us for further assistance.

Cordially yours,

José R. Caballero-Mercado
Acting Chairman

Enclosure

COMMENTS OF THE COMMONWEALTH OF PUERTO RICO

COMMONWEALTH OF PUERTO RICO
OFFICE OF THE GOVERNOR
PUERTO RICO PLANNING BOARD

Minillas Governmental Center, North Bldg.
De Diego Ave. Stop 22
P. O. Box 41119, San Juan, P. R. 00940 - 1119

31 DIC 1996

Ms. Ada Squires
Policy Review Branch
Policy Division
Attn: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Ms. Squires:

This is in reference to the letter dated November 20, 1996 requesting comments on the document Final Feasibility Report and Environmental Assessment, December 1996 for Río Nigua at the Municipality of Salinas.

The existing flooding condition in the municipality means serious socio-economic grow restrictions withing the urbanized area and its adjacent lands. Also, it represents a threat to the lives and personal properties. As a matter of fact, the municipality does not have an urban expansion plan due to the flooding classification. According with the Flood Insurance Study Río Majada Basin prepared by the Corps of Engineers for the Federal Emergency Management Agency, the urban area is located within the floodway of Río Nigua, which implies restriction for new development and substancial improvements. This was reflected through the Territorial Ordinance Plan promoted by the Municipality of Salinas, based on the Municipal Autonomy Law. The document has the objetive to prepare a Territorial Plan and to clasify the lands and its uses. Flooding condition is one of the main obstacles to classify the lands.

We recommend the flood control project of Río Nigua near the urban core of the Municipality of Salinas and the Coco Community. Is is expected through this project that the municipality will have opportunities of redevelopment and densification all the urban area.

Cordially yours,

Norma E. Burgos-Andújar
Chairwoman

c: Hon. Pedro J. Roselló

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

DEC 6 1996

ER 96/749

Mr. Raleigh H. Leef
Acting Chief, Policy Division
Directorate of Civil Works
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

Dear Mr. Leef:

The Department of the Interior has completed its review of the proposed Chief of Engineers report and related documents concerning the Rio Nigua at Salinas, Puerto Rico. The current plan calls for the construction of levees at Coco community at the lower Rio Nigua. Some minor channel improvements are also planned.

The construction of the two levees will not impact wetlands or our trust resources. The proposed channel improvements will not impact the designated Coastal Barrier PR-47, which comprises the mouth of the Rio Nigua.

Based on our review of the existing documentation and current Corps proposal we believe that the Department's natural resources would not be adversely impacted by the project as currently proposed. Thank you for the opportunity to provide these comments.

Sincerely,

Willie R. Taylor

Willie R. Taylor, Director
Office of Environmental Policy
and Compliance

COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

DEC 10 1996

Ms. Ada Squires
U.S. Army Corps of Engineers
Policy Review Branch
Attn: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

Dear Ms. Squires:

The Environmental Protection Agency (EPA) has reviewed the final feasibility report and Environmental Assessment (EA) for the flood control project for the Rio Nigua in the vicinity of the town of Salinas, Puerto Rico.

The draft EA evaluated several structural and nonstructural alternatives, as well as the no-action alternative, to address planning objectives. The plan recommended in the final EA consists of a levee system to provide flood protection to the town of Salinas and to Coco community.

As we stated in our letter of July 11, 1996 regarding the draft EA, we do not anticipate that implementation of the preferred alternative will result in significant adverse impacts to the environment. Accordingly, EPA has no objections to its implementation.

If you have any questions concerning this letter, please contact Deborah Freeman of my staff at (212) 637-3730.

Sincerely yours,

Grace Musumeci, Chief
Environmental Review Section
Strategic Planning and Multi-Media Programs Branch

RIO NIGUA AT SALINAS, PUERTO RICO

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PE (10-1-7a)

15 APR 1997

SUBJECT: Rio Nigua at Salinas, Puerto Rico

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on flood damage reduction along the Rio Nigua at Salinas, Puerto Rico. It is accompanied by the report of the district and division engineers. These reports are in final response to a resolution by the Committee on Public Works and Transportation of the House of Representatives dated 1 October 1986. The study resolution requested that the Secretary of the Army, acting through the Chief of Engineers, make a survey of the Rio Nigua at Salinas, Puerto Rico, and such tributary streams as may be necessary, to determine the advisability of providing improvements for flood control, water supply, and allied purposes. Preconstruction engineering and design activities will be continued under this authority.

2. The reporting officers recommend a flood damage reduction project primarily involving levee construction of two separable elements. These elements include a 2.96-kilometer (1.84-mile) levee to provide flood protection along the east bank of the Rio Nigua between Puerto Rico Highway 52 and the mouth of the river and a 3.98-kilometer (2.47-mile) levee to provide flood protection to the Coco community, upstream of Puerto Rico Highway 52. These levees are designed to protect against a flood event that has an expected annual exceedance probability of about 1 percent. No fish and wildlife mitigation features are required.

3. The estimated first cost of the recommended plan, based on October 1996 price levels, is $12,802,000, of which $6,920,000 would be Federal and $5,882,000 would be non-Federal. The total average annual cost, based on a discount rate of 7 3/8 percent and a 50-year period of analysis, is estimated at $1,078,000, including $66,000 for operation, maintenance, repair, replacement, and rehabilitation. The average annual economic benefits are estimated at $3,046,000. The benefit-cost ratio is 2.8 to 1. The proposed plan is the national economic development (NED) plan, and each of the separable levee elements is economically justified and represents the NED plan for that element.

4. Washington level review indicates that the proposed plan is technically sound, economically justified, and environmentally acceptable. The proposed project complies with applicable Corps planning procedures and regulations. Also, the views of interested parties, including Federal, State, and local agencies have been considered.

5. Accordingly, I recommend that improvements for flood damage reduction in the Rio Nigua at Salinas area be authorized subject to cost sharing as required by Public Law 99-662, the Water Resources Development Act of 1986, as amended by Section 202 of Public Law 104-303, the Water Resources Development Act of 1996. This recommendation is also subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including the following requirements:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of total project costs as further specified below:

(1) Provide, during construction, a cash contribution equal to 5 percent of total project costs;

(2) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project;

(3) Provide or pay to the Federal Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(4) Provide during construction any additional costs as necessary to make its total contribution equal to 35 percent of total project costs.

b. Provide all lands, easements, and rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project;

c. Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, maintenance, repair, replacement, or rehabilitation of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, wasteweirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes;

d. Provide during construction any additional amounts as are necessary to make its total contribution equal to 35 percent of total project costs assigned to structural flood control;

e. For so long as the project remains authorized, pay 100 percent of costs to operate, maintain, repair, replace, and rehabilitate the completed project or functional portion of the project prescribed by the Federal Government;

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor now or hereafter owns or controls for access to the project for the purpose of inspection, and, if necessary after failure to perform by the non-Federal sponsor, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

g. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

h. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

i. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the operation, maintenance, repair, replacement, and rehabilitation of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal sponsor with prior specific written direction, in which case the Non-Federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the Federal Government and the Non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the operation, maintenance, repair, replacement, or rehabilitation;

k. As between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for the operation, maintenance, repair, replacement, and rehabilitation of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

m. Comply with all applicable Federal and Commonwealth laws and regulations including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army";

n. Provide 35 percent of that portion of total cultural resource preservation, mitigation and data recovery costs attributable to flood control that are in excess of 1 percent of the total amount authorized to be appropriated for flood control;

o. Participate in and comply with applicable Federal floodplain management and flood insurance programs in accordance with Section 402 of Public Law 99-662, as amended;

p. Within 1 year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. The plan shall be prepared in accordance with guidelines developed by the Federal Government and must be implemented not later than 1 year after completion of construction of the project;

q. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance of the project;

r. Not less than once each year, inform affected interests of the extent of the protection afforded by the project; and

s. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

6. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the Commonwealth of Puerto Rico; interested Federal agencies; and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

JOE N. BALLARD
Lieutenant General, USA
Chief of Engineers

REPORT OF THE DIVISION ENGINEER

DEPARTMENT OF THE ARMY
SOUTH ATLANTIC DIVISION, CORPS OF ENGINEERS
ROOM 322, 77 FORSYTH ST, SW
ATLANTA, GEORGIA 30303-3490

September 30, 1996

NOTICE OF COMPLETION
Feasibility Study and Environmental Assesment
Rio Nigua at Salinas
Salinas, Puerto Rico

COMPLETION OF STUDY

Notice is hereby given that the Jacksonville District and the South Atlantic Division Engineers have completed a final feasibility study and environmental assessment for flood damage reduction along the Rio Nigua near Salinas, Puerto Rico. The study was prepared under authority provided by resolution of the Committee on Public Works and Transportation of the United States House of Representatives dated October 1, 1986. A Finding of No Significant Impact (FONSI) statement is included in the report.

FINDINGS AND RECOMMENDATIONS

The recommended plan of improvement consists of a 2.96-kilometer (1.84-mile) levee along the east bank of the Rio Nigua between Puerto Rico Highway 52 (PR 52) and the mouth of the river, erosion protection at the east abutment of the PR 52 bridge, a new bridge and ramp at Puerto Rico Highway 1 (PR 1), and a levee segment to protect the intersection of PR 1 and PR 52. The plan also includes a 3.98-kilometer (2.47-mile) levee to provide flood protection to the Coco community.

Based on August 1996 prices, estimated first cost of the plan is $12,713,600, of which $6,836,200 would be Federal while $5,877,400 would be non-Federal. Average annual benefits and costs based on an interest rate of 7 5/8 percent are estimated at $3,046,800 and $1,071,700 respectively with resulting benefit-cost ratio of 2.8.

The recommendations contained herein reflect the information available at this time and current policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation of funding.

COORDINATION

The report has been coordinated with concerned local interests; the Commonwealth of Puerto Rico including the Puerto Rico State Historic Preservation Officer, Puerto Rico Department of Natural and Environmental Resources, and the Puerto Rico Planning Board; and Federal agencies including the U.S. Geological Survey, the Environmental Protection Agency, and the U.S. Fish and Wildlife Service. The Final Coordination Act Report from the Fish and Wildlife Service has been received.

The Puerto Rico Department of Natural and Environmental Resources is the project sponsor and by letter dated August 19, 1996 expressed support for the conclusions and recommendations of the reports and their intent to secure funding for project implementation.

PUBLIC INVOLVEMENT

The draft feasibility report and environmental assessment were circulated for the 45-day public review period which ended July 31, 1996. Comments and responses are included in the final report.

REVIEW AND AUTHORIZATION PROCESS

Prior to adoption of the proposed project, the study evaluations and report findings will be reviewed by the Chief of Engineers and the Assistant Secretary of the Army for Civil Works. A coordinated review, including affected states and other Federal agencies, will also be accomplished at that time. The Chief of Engineers will review the report and forward a recommendation to the Secretary of the Army.

If the recommendation of the Chief of Engineers is significantly different from the recommendation coordinated with state and Federal Agencies, interested parties will be afforded an opportunity to comment further prior to submission of the Chief's report to the Secretary. The Assistant Secretary of the Army, in consultation with the Office of Management and Budget, then establishes the Administration position on whether the proposal should be recommended to Congress for authorization.

VIEWS OF INTERESTED PARTIES

Interested parties may present written views on the reports to the Chief of Engineers and the Secretary of the Army through the Directorate of Civil Works. Such communications should be mailed to the Directorate of Civil Works, Policy Review and Analysis Division, Policy Review Branch, ATTN: CECW-AR, 7701 Telegraph Road, Alexandria, Virginia 22315-3861, in time to reach the Policy Review Branch within 30 days from the date of this notice. Copies of information received by mail will be regarded as public information unless the correspondent requests otherwise. Such a request will limit the usefulness of the information because of the need for full public disclosure of all factors relevant to the decision on project approval.

FINAL ACTION BY THE CHIEF OF ENGINEERS

The Chief of Engineers will not submit a recommendation to the Secretary on the report until after the expiration of this notice or any extension thereof that may be granted, and full consideration of all information submitted in response thereto.

REPORT INFORMATION

Further information concerning the study and report may be obtained from the District Engineer, Jacksonville, Florida, or the Deputy District Engineer for the Antilles in San Juan, Puerto Rico. Requests for additional copies of the report should be addressed to the District Engineer, U.S. Army Engineer District Jacksonville, P.O. Box 4970, Jacksonville, Florida 32232-0019, or the Deputy District Engineer for the Antilles, Antilles Office, San Juan Area Office, 400 Fernandez Juncos Avenue, San Juan, Puerto Rico 00901. The report may be reviewed by interested parties at the above office. Interested parties may purchase copies of the report at the cost of reproduction ($40.00). Requests should be made to the offices addressed above. Checks or money orders should be made payable to the Finance and Accounting Officer, U.S. Army Engineer District, Jacksonville, or the Deputy District Engineer for the Antilles.

Additional copies of the report will also be on file and available for public review at the Department of Natural and Environmental Resources central offices in San Juan, Puerto Rico, and the City Hall of the Municipality of Salinas, Puerto Rico.

Please pass along a copy of this public notice to anyone who may be interested in the report and who has not received a copy.

R. L. VanAntwerp
Brigadier General, U.S. Army
Division Engineer

ADDENDUM January 1997

ENCLOSURE 1

ECONOMICS OF THE RECOMMENDED PLAN
($1,000 of October 1996)

Itemized Features	Town and Playa	Coco	Total Project
Total First Cost	$ 9,948.0	$2,854.0	$12,802.0
Interest During Construction	394.3	137.3	531.6
Total Investment Cost	$10,342.3	$2,991.3	$13,333.6
Interest & Amortization	$ 785.1	$ 227.0	$ 1,012.1
Annual O&M Costs	45.5	20.5	66.0
TOTAL ANNUAL COST	**$ 830.6**	**$ 247.5**	**$ 1,078.1**
Annualized Benefits			
Inundation Reduction	1,143.2	1,667.9	2,811.1
Agricultural	113.3	0.0	113.3
Employment	37.4	13.1	50.5
Flood Insurance	8.2	0.0	8.2
Advance Bridge Replacement	62.7	0.0	62.7
TOTAL ANNUAL BENEFITS	**$ 1,364.8**	**$1,681.0**	**$ 3,045.8**
NET NED BENEFITS	**$ 534.2**	**$1,433.5**	**$ 1,967.7**
BENEFIT TO COST RATIO	**1.6/1**	**6.8/1**	**2.8/1**

*Benefits and Costs Amortized at 7.375%

*Period of Analysis = 50 years

RECOMMENDED PLAN
COST SHARING OF TOTAL FIRST COST
($1,000 of October 1996)

DESCRIPTION	TOTAL	FEDERAL	NON-FEDERAL
FLOOD CONTROL ITEMS			
Levees and Channels	$ 7,560	$7,560	$ 0.0
Relocations, Roads, Bridges, Utilities, and Structures	2,624	0	2,624
Lands and Damages	2,618	0	2,618
TOTAL FLOOD CONTROL COST	$12,802	$ 7,560	$ 5,242
5% Non-Federal Contribution		-640.1	+640.1
SUBTOTAL		6,919.9	5,882.1
25% Minimum Contribution			$ 3,200.5
50% Maximum Contribution			6,401.0
Contribution Adjustment (not to exceed 50% maximum)		0	0
SUBTOTAL		6,919.9	5,882.1
Ability to pay adjustment		0	0
SUBTOTAL		6,919.9	5,882.1
TOTAL FIRST COST		6,919.9	5,882.1

RIO NIGUA AT SALINAS FEASIBILITY REPORT
12490

SYLLABUS

The Río Nigua at Salinas feasibility study was conducted under the authority of a Resolution by the Committee of Public Works and Transportation of the U.S. House of Representatives dated October 1, 1986. A detailed study for the Río Nigua was initiated in March 1992. The study focused on the formulation and evaluation of flood control plans to solve the serious flooding problems resulting from the overflow of Río Nigua in the vicinity of the town of Salinas, Puerto Rico. This was a cost-shared study effort with the Puerto Rico Department of Natural and Environmental Resources (DNER) serving as the local sponsor. This report is the final response to study authority.

The Río Nigua basin is located in the south-central region, about 33 kilometers east of the city of Ponce, the second largest and most important city of Puerto Rico. It comprises the municipalities of Salinas, Guayama, and Cayey. The basin has about 142 square kilometers of flat to mountainous terrain. Heavy rainfall combined with steep slopes of the upper basin can produce high discharges in a relatively short period of time. Flooding in the study area affects over 3,000 families and numerous public buildings and facilities. Total expected annual damages associated with floods in the study area are estimated at $2.88 million.

The recommended plan of improvements for the Río Nigua south from PR Highway 52 consists of a 2.96 kilometers levee along the east bank of the river extending from the highway down to end east from the mouth of the river in the coastal area. The plan includes protection measures against erosion for the east abutment of the highway bridge, a new bridge and ramp at PR Highway 1, and a levee segment to protect the intersection between highways 52 and 1. Proposed levee project is expected to contain the one percent chance exceedence frequency flood (100-year) with a 99.7 percent probability. The structure would have a 0.01 percent chance of being overtopped in any given year. The recommended plan also includes a 3.98 kilometers levee to provide flood protection to the Coco community, upstream PR Highway 52. This levee project is expected to contain the one percent chance exceedence frequency flood with a 91.1 percent probability. The structure would have a 0.33 percent chance of being overtopped in any given year.

Total project cost of the components of the recommended plan for the Río Nigua de Salinas study area is $12,713,600, while annual cost including interest during construction and O&M is $1,071,700. Implementation of the plan will result in National Economic Development (NED) annual benefits of $3,046,800 and a benefit-to-cost ratio of 2.8/1.0. The recommended plan is the NED plan. Pertinent economic data for the recommended plan is based on August 1996 price level and interest rate of 7.625 percent. Under the current cost-sharing policy, the Federal Government cost would be $6,836,200 while the local sponsor's share would amount to $5,877,400.

RIO NIGUA AT SALINAS FEASIBILITY REPORT
12490

MAIN REPORT

LIST OF APPENDICES

GENERAL INVESTIGATION

FLOOD CONTROL

SEPTEMBER 1996

[illegible] January 1997

RIO NIGUA AT SALINAS

PUERTO RICO

FINAL FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

US Army Corps
of Engineers
South Atlantic Division
Jacksonville District

DRNA

RIO NIGUA AT SALINAS FEASIBILITY REPORT
12490

MAIN REPORT

CONVERSION FACTOR TABLE

LENGTH

1 kilometer = 0.6214 mile
1 meter = 3.2808 feet
1 centimeter = 0.3937 inch
1 millimeter = 0.03937 inch

AREA

1 square kilometer = 0.3861 square mile
1 square kilometer = 247.1054 acres
1 hectare = 2.4711 acres
1 square meter = 1.1960 square yards
1 square meter = 10.76 square feet

VOLUME

1 cubic meter = 1.3080 cubic yards
1 cubic meter = 35.3147 cubic feet

VELOCITY

1 meter per second = 3.2808 feet per second

FLOW RATE

1 cubic meter per second = 35.3147 cubic feet per second
1 cubic meter per second = 22.8241 million gallons per day (mgd)
1 liter per second = 0.0353 cubic feet per second

WEIGHT

1 metric ton = 2204.622 lbs.
1 metric ton = 1.1023 short tons

RIO NIGUA AT SALINAS FEASIBILITY REPORT
12490

MAIN REPORT

ABBREVIATIONS AND ACRONYMS

ALERT	Automated Local Evaluation in Real Time
DNER	Puerto Rico Department of Natural and Environmental Resources
EFIP	Emergency Flood Insurance Program
EPA	Environmental Protection Agency
EQB	Puerto Rico Environmental Quality Board
FEMA	Federal Emergency Management Agency
FIA	Federal Insurance Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FWS	United States Fish and Wildlife Service
IWWSIP	Island Wide Water Supply Implementation Plan
IWWSS	Island Wide Water Supply Study
NED	National Economic Development
NFIP	National Flood Insurance Program
PRASA	Puerto Rico Aqueduct and Sewers Authority
PRPB	Puerto Rico Planning Board
SHPO	State Historic Preservation Office
USGS	United States Geological Survey

RIO NIGUA AT SALINAS, PUERTO RICO
FEASIBILITY REPORT

MAIN REPORT
AND
ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

RIO NIGUA AT SALINAS FEASIBILITY REPORT

MAIN REPORT

TABLE OF CONTENTS (Cont.)

RIO NIGUA AT SALINAS FEASIBILITY REPORT

MAIN REPORT

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

RIO NIGUA AT SALINAS FEASIBILITY REPORT

MAIN REPORT

TABLE OF CONTENTS (Cont.)

Page

LIST OF FIGURES

Figure

LIST OF PLATES

(Plates follow text.)

Plate

RIO NIGUA AT SALINAS FEASIBILITY REPORT
12490

MAIN REPORT

I. INTRODUCTION

This report presents the results of investigations into flooding and related problems resulting from overflows of Río Nigua at the town of Salinas, Puerto Rico. The study was requested by the Puerto Rico Resident Commissioner in Washington in letter dated June 19, 1985, and it was authorized in October 1986. The Reconnaissance Report was initiated in March 1989 and completed in March 1990. Funds to initiate feasibility study were received in March 1992. A draft feasibility report was completed in February 1996. The Feasibility Review Conference was held on April 1996. This was a cost-shared study effort with the Puerto Rico Department of Natural and Environmental Resources (DNER) serving as the local sponsor.

II. AUTHORITY AND PURPOSE

The Río Nigua at Salinas feasibility study was conducted under the authority of a Resolution by the Committee of Public Works and Transportation of the U.S. House of Representatives dated October 1, 1986, which reads as follows:

> *Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that, in accordance with Section 204 of the River and Harbor Act of 1970 (Public Law 91-611), the Secretary of the Army, acting through the Chief of Engineers, is hereby requested to make a survey of the Río Nigua at Salinas, Puerto Rico, and such tributary streams as may be necessary, to determine the advisability of providing improvements for flood control, water supply and allied purposes.*

The purpose of the feasibility study was to evaluate flooding problems along Río Nigua at the town of Salinas to include a sector (subdivision) south of the town known as Playa de Salinas and Coco community (about 4 kilometers upstream). Also, to determine the economic, engineering, and environmental feasibility of implementing urban flood damages reduction measures.

This report addresses flood related issues and presents a recommended plan to reduce the area's serious flooding problem maximizing net benefits.

This report is the final response to study authority.

III. SCOPE

A. Study Area

The Río Nigua watershed is located in the south-central region of Puerto Rico (Figure 1). It covers an area of about 142 square kilometers and includes portions of the municipalities of Salinas, Guayama, and Cayey. Study efforts were concentrated in analyzing flooding problems in the developed areas within the town of Salinas, to include the Playa de Salinas and Coco community sectors located about 4 kilometers north (Figure 2). For purpose of analysis and discussion, the detailed study area is divided into separate areas. These are: the town of Salinas to include Playa de Salinas and the Coco community areas.

B. Study Participants and Coordination

Coordination of this report was accomplished through numerous formal and informal meetings with various Commonwealth and Federal agencies, municipality officials, various interested groups, and the residents of the flood plain. Table 1 shows the participating government agencies. The study was thoroughly coordinated with the DNER, which is the local sponsor.

The meetings held with representatives from the various government agencies were aimed at the collection of data necessary for the study and at the assessment and evaluation of the various flood control alternatives considered. A major objective of the coordination effort is to involve the local governments and citizen representatives as equal partners in the study process.

As part of the study process, several technical review conferences were held between District, Division and Washington level review personnel to discuss and evaluate study findings, plan formulation and risk analysis. The purpose of a Technical Review Conference (TRC)is to review and concur in the without project condition, the alternative being evaluated, and the methodology being used in the evaluation; and to provide guidance and assistance as needed to complete the report. This report incorporates recommendations and guidance provided by TRC members.

C. Organization of the Report

The results of the study are presented in a Main Report, an Environmental Assessment (EA), and six appendices. The Main Report includes a description of the basin, an analysis of the study area's flooding problems, plan formulation and evaluation process, and the conclusions and recommendations of the study. The EA includes a description and analysis of the study area's environmental resources as well as the evaluation of the potential effects the alternative plans of action considered would have on these resources and the rest of the area's human environment. Throughout the document, reference is made to inputs and comments from other federal resources agencies, particularly the U.S. Fish and Wildlife Service (FWS) and the Environmental Protection Agency (EPA). The appendices provide the supporting

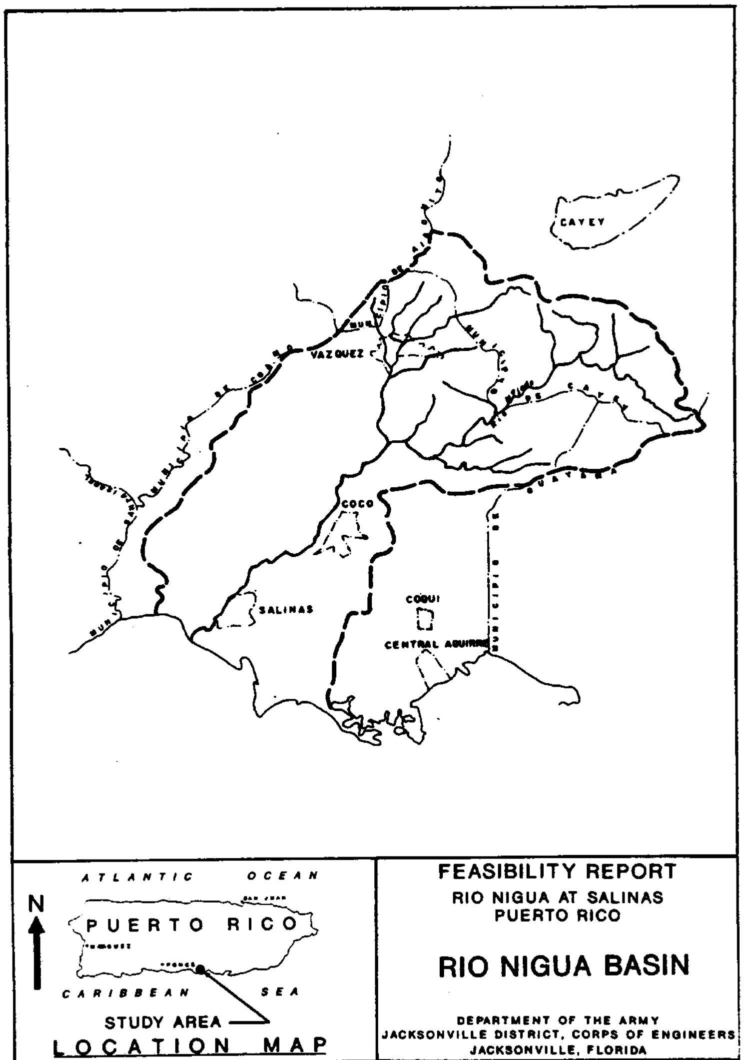

CAYEY
VAZQUEZ
COCO
SALINAS
COQUI
CENTRAL AGUIRRE
ATLANTIC OCEAN
N
PUERTO RICO
CARIBBEAN SEA
STUDY AREA
LOCATION MAP
FEASIBILITY REPORT
RIO NIGUA AT SALINAS
PUERTO RICO
RIO NIGUA BASIN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

FIGURE 1

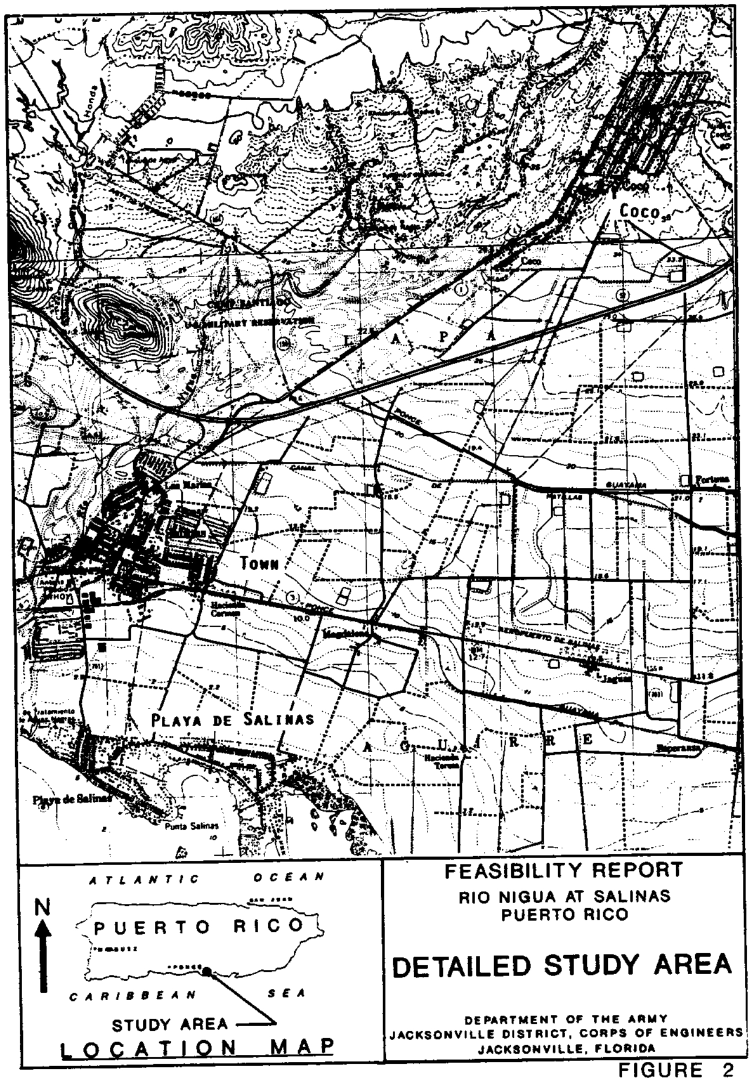

Coco
TOWN
PLAYA DE SALINAS
Playa de Salinas
Punta Salinas
ATLANTIC OCEAN
PUERTO RICO
CARIBBEAN SEA
N
STUDY AREA
LOCATION MAP
FEASIBILITY REPORT
RIO NIGUA AT SALINAS
PUERTO RICO
DETAILED STUDY AREA
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

FIGURE 2

TABLE 1

PARTICIPATING GOVERNMENT AGENCIES

Federal	Commonwealth
Dept. of the Interior U.S. Geological Survey U.S. Fish & Wildlife Service National Park Service	Dept. of Natural and Environmental Resources (DNER) (Local Sponsor)
Dept. of Transportation Federal Highway Administration	Office of the Governor Planning Board Environmental Quality Board
Environmental Protection Agency	Legislature of Puerto Rico House of Representatives Senate
Dept. of Housing & Urban Development	Office of the Resident Commissioner
Dept. of Agriculture Natural Resources Conservation Service	Regulations and Permits Administration
Dept. of Commerce National Weather Service Office of Coastal Zone Management National Marine Fisheries Service	Civil Defense
Federal Emergency Management Agency	Dept. of Transportation and Public Works
	Highway Authority
	Historic Preservation Office
	Dept. of Agriculture
	Office of the Budget
	Dept. of Sports and Recreation
	Dept. of Housing
	Dept. of Social Services
	Dept. of Education
	Police Dept.
	Aqueducts and Sewers Authority
	Electric Power Authority
	Municipality of Salinas Office of the Mayor Dept. of Public Works Civil Defense

data and detailed investigations conducted as part of the study. These include: Appendix A, Hydrology and Hydraulics; Appendix B, Geotechnical Studies; Appendix C, Design and Cost Estimates; Appendix D, Coordination; Appendix E, Real Estate Analysis; and Appendix F, Economic Analysis.

IV. DESCRIPTION OF THE RIO NIGUA BASIN

A. Physiography

1. The river basin. The Río Nigua basin is located in the south-central coast of Puerto Rico about 33 kilometers east of the city of Ponce. It comprises the municipalities of Salinas, Guayama, and Cayey. The basin has about 142 square kilometers of flat to mountainous terrain. Principal tributaries are the Río Majada, with a drainage area of 57.5 square kilometers, and the Río Lapa, with an area of 31.3 square kilometers. The head waters of Río Nigua originate in the southern slopes of the Cordillera Central mountain range, near the town of Cayey, at an elevation of about 860 meters (NGVD). The river flows about 29 kilometers toward the southwest, passing west of the town of Salinas, to discharge into the Caribbean Sea. High mountains of volcanic origin are common in the northern and northeast part of the basin. The topography of the southern portion is characterized by gentle sloping hills and a coastal plain. The coastal plain was separated from the rest of the basin by the construction of the PR Highway 52 which crosses the flood plain from east to west. PR Highway 52 is the main land connection between the cities of San Juan and Ponce (the largest in the island). The basin is bounded on the north by the Río de la Plata basin, on the east by the Río Guamaní and Río Seco basins, and on the west by Río Jueyes.

2. Waterworks. There are no major waterworks in the basin. There are a few small diversion structures and irrigation channels for domestic and agricultural use within the basin. Most of the existing water demand is served from ground water sources. At present, all the water for domestic use is provided by the Puerto Rico Aqueducts and Sewers Authority (PRASA) through ten shallow wells producing a total of 2.87 MGD. In accordance with PRASA estimates, existing sources in the region should provide for projected increase in water demand.

3. Climate. The island of Puerto Rico possesses a tropical marine climate. Warm temperatures with little variations, steady ocean breezes, and abundant rainfall in the north region result from a constant high level of solar radiation, the presence of trade winds from the northeast, and the mountainous topography of the island. The south region is basically warm and dry throughout the year. Mean annual temperature within the Río Nigua basin ranges from about 25 degrees Centigrade during the winter to 28 degrees during summer. Mean annual precipitation within the basin varies from 196 centimeters in the upland to 112 centimeters in the coastal plain. Hurricanes and tropical storms can produce very heavy rainfall late in summer and in fall. Cold fronts may also create heavy rainfall during winter and early in spring.

4. Soils. In accordance with the U.S. Soil Conservation Service, the principal soil types found in the basin are: Descalabrado-Rock land complex, Caguabo clay loam, Jácana clay, Guamaní silty clay loam, and Cobbly alluvial land. The Descalabrado-Rock land complex and the Caguabo clay loam are found on very steep side slopes and ridge tops of the semiarid volcanic uplands. These soils are well drained and shallow. The Jácana soil is well drained and moderately deep. This soil is found on gently sloping and sloping foot slopes as well as on low rolling hills on the semiarid area. All of the above soils are underlaid by impervious layers with a high runoff potential. The Cobby alluvial land and the Guamaní soils are found along streams, rivers, and in the river flood plain. These soils have a moderately low runoff potential.

B. Socioeconomic Profile

The Municipality of Salinas was officially established in 1851. It covers an area of about 179 square kilometers. It is bounded in the north by the municipalities of Cayey, Coamo, and Aibonito; Guayama to the east; Santa Isabel to the west; and the Caribbean Sea to the south. It is territorially subdivided in six "barrios" or wards. The principal urban clusters within the Río Nigua flood prone area are the town of Salinas, the sector Playa de Salinas, and the Coco community. Playa de Salinas is basically an extension of the town towards the coastal area with a very active economic activity. All these urban areas are located on the east bank of the Río Nigua. Camp Santiago, a military installation used for training and a US Navy communications facility, is also within the flood prone area. However, Camp Santiago is located on the west riverbank.

Under existing government urban development regulations, the town of Salinas and communities in the vicinity are located within the floodway zone of Río Nigua. Many commercial buildings and the public hospital are within the flood prone area. This flooding condition imposes a strong development restriction and associated high unemployment rate. The municipality is connected to the island's primary highway system through PR Highways 1, 3, and 52. There are several second and third order highways and municipal roads linking all the "barrios" and rural communities within each other and with the neighboring municipalities.

1. Population. According to the 1990 US Census of Population and Housing, total population for the Municipality of Salinas was 28,335, a 7 percent increase from 1980. Urban population represents 47 percent of the municipality's total population. Most of the total population live within the flood prone area. The Playa de Salinas sub-division is influenced by a floating tourist population during weekends attracted by beach and boating related activities. A second source of fluctuating population is the Camp Santiago training facilities. A typical training activity could temporary increase population within the flood prone area on about 4,800 persons. In 1994, about 480,000 persons were housed in these training facilities. Another source of transient population within the municipality is the Albergue Olímpico, a government-owned (operated by a non-profit organization) sports training facility that can house up to 430 persons training for international sports events. The facilities within the Albergue also includes a junior high and high school (boarding school) for sports-talented students. The school

facilities can accommodate up to 300 students and 60 technical and administrative personnel. These sport-related facilities are used and/or visited by about 1 million persons each year.

2. Economic base. The economic structure of the municipality is based on activities associated with the agriculture, manufacturing, government, tourism, and services activities. The Puerto Rico Department of Labor estimated the civilian labor force at 29,500 persons in November 1995 for the Salinas, Guayama, and Patillas Labor Market Area. The predominant employment-generating sectors for the area are government, manufacturing, agriculture, and a growing services, commerce, and insurance-finance sector. Table 2 shows the distribution of employed people by principal occupational category for the study area as of November 1995. About 39 percent are government employees, while about 22 percent hold agricultural and related occupations. Manufacturing comprises the third employment source in the Salinas labor area.

TABLE 2
DISTRIBUTION OF EMPLOYED PEOPLE BY MAJOR ECONOMIC SECTOR
AS OF JUNE 1995
(Salinas, Guayama, and Patillas Labor Area)

Total Labor Force		29,500
Employed	23,000	
Unemployed	6,500	
Unemployed Rate	21.9%	
Distribution:		
Manufacturing		3,800
Nonmanufacturing		14,200
Construction	320	
Transportation, Communications, etc.	150	
Trade	2,900	
Finance	280	
Services	1,620	
Government	8,900	
Agriculture and Related		5,000

C. Land Use

The vegetation cover of the uplands is generally good. The land use in the uplands is primarily forest, while in the lowlands or flood prone area is covered with grasses and intermittently spaced trees. Agriculture accounts for 52 percent of the basin land use, while 44 percent is under forest cover. Urban development is limited to about 4 percent. Forest cover ranges from fine woody growth to solid crown cover.

D. Natural Resources

1. Water resources. Surface water supply sources in the region of Salinas are limited. This area is designated as sub-tropical dry with a low annual rainfall. Rivers in the region have periods of very low or no flow in the coastal area. As a result, a sand berm usually blocks the river mouth during months of little rainfall. This berm is bridged during the first large flood of the season. Estuarine and riverine mangoves, salt flats and seasonal salt marshes are common in these systems. The quality of the surface and ground water is suitable for most uses. Rio Nigua has a low base flow and in the lower reaches is intermittent because most of the flow in the upper basin is diverted for irrigation. According to the U. S. Geological Survey (USGS), the mean annual flow of Río Nigua (upper basin) is about 0.39 cms. Seasonal fluctuations can reduce the flow as low as 0.13 cms. Most of the water supply comes from adequate groundwater sources. Ground water is of good chemical quality. No evidence of salt water intrusion has been detected.

2. Environmental resources. Identification of significant environmental resources in the detailed study area was made by U.S. Army Waterways Experiment Station surveys, in coordination with the Commonwealth Department of Natural Resources, Natural Heritage Program and the Boquerón Field Office, U.S. Fish and Wildlife Service. Significant cover types include limited riverine and estuarine wetlands. No threatened or endangered plant and animal species or Commonwealth species of special concern were identified. Most lands outside the town and Coco community are in pasture or open grassland. Because they have been highly altered by centuries of agriculture and human disturbance, they do not provide significant habitat. Fires are frequent in this arid environment, limiting development of woody cover. Birds and lizards, belonging to widespread, human tolerant species, are the most visible components of the fauna. Riverine wetlands development has been restricted by the arid climate to the immediate Río Nigua channel only, and is dominated by sedges and shrubs that tolerate widely fluctuating water levels. At the level of Coco community the channel is barren of vegetation and is virtually dry for many months each year. Most of the land-use along the east bank, downstream from Highway 52, is residential. In the town of Salinas there is a low-crest concrete levee on the east bank about 300 meters long. This structure provides bank stability in the vicinity of the town but does not allow plant cover to develop. Near the river mouth below Highway 1 a mangrove wetland has developed along the river bank and on the first terrace of the river. Tidal influence penetrates upstream almost to the southern town limits. The mangroves are limited to a line of red mangroves along the banks and a basin forest dominated by black and white mangroves on the lower delta (refer to the Coordination Act Report of FWS, reproduced in the Environmental

Assessment for a map). This area is Puerto Rico Coastal Barrier Segment PR-47. Additional estuarine wetlands (salt flats covered by low grasses and succulent herbs)extend to the east, towards Playa de Salinas.

The most noticeable wildlife elements are wading birds that use the delta wetlands. Río Nigua provides foraging habitat for herons, egrets and migratory shorebirds. The mangrove-dominated estuary also shelters juvenile fish and exports organic matter to offshore communities. The mangrove area at the mouth of the river is used for bank fishing, crab harvesting, and picnicking. However, productivity of this habitat is limited by scarce flow during the dry season. Continual grazing of the vegetation within the channel bank by domestic animals limits vegetation development.

3. Mineral resources. Sand and gravel deposits have been exploited on a big scale along the Río Nigua basin. Two active quarries have provided millions of metric tons of excellent river sand and gravel for the construction industry. The municipal government periodically removes an undetermined amount of sand from the large sand bar located at the mouth of the river. In accordance to DNER, there are two private companies with a total authorized annual gravel mining volume of 130,000 cubic meters along the Río Nigua natural channel currently under operation.

E. Cultural Resources

The area within the Municipality of Salinas has been occupied by aboriginal groups since the Archaic period (325 B.C.). During the contact period (late fifteenth century), the area was associated with the Taíno chief, Cacique Abey. In 1776 the area of Salinas was occupied by about 100 people and was part of the parish of the Municipality of Coamo. Salinas remained a "barrio" (ward) of Coamo until 1847 when it became a territory of Guayama. The town was officially founded in 1851. In 1902, the Legislative Assembly of Puerto Rico approved the annexation of Salinas as an independent municipio from Guayama. In 1878, 3,106 persons inhabited the town of Salinas.

The earliest Spanish economic activities in Puerto Rico were related to the exploitation of gold and silver. However, during the sixteenth century, this was replaced by the sugar industry. The emphasis on sugar became so intensive that by the end of the nineteenth century sugar milling experienced a major technological shift to steam power, and large agro-business complexes (haciendas or *estancias*) were established. Some haciendas even issued coinage to their workers to purchase items at their own stores. Within the region of Salinas, the major economic activities consisted of livestock production, three sugarcane-producing haciendas, and three coffee-production *estancias*. Central Aguirre, a sugar-producing mill, was founded in 1900. The mill was closed in 1990, causing severe unemployment in the region.

Although earlier systems probably existed, an extensive irrigation system was present in the municipio by the mid-nineteenth century. Plans of the system from 1860 show two canals from the Río Majada and Río Lapa. In 1865 the two canals were combined into one system which irrigated the sugarcane fields throughout the Salinas valley. The irrigation system in the region continued to be expanded to facilitate sugarcane production. Due to frequent droughts, the sugarcane industry induced the insular government to construct an irrigation system from Ponce to Guayama. The Central Aguirre Sugar Company was the major force in lobbying for construction of the canal system. This system was constructed at a cost of $4 million between 1910 and 1914.

The population of Salinas continued to grow throughout the first half of this century. In 1899 the population was 5,731. By 1950 it had grown over 300 percent to 23,432. In 1990, the population of Salinas was recorded at 28,335 individuals.

V. PROBLEMS, NEEDS, AND OPPORTUNITIES

A. Flooding

1. River flooding. The Río Nigua basin is subject to relatively high intensity precipitation of short duration, which combined with the steep upper slopes of the river, produces a very short time of concentration. Severe flooding in the basin is generally associated with the passage of hurricanes, tropical storms, tropical depressions, tropical waves, and stationary fronts through or near the island.

The town of Salinas, located in the lower valley, and the Coco community, located within the mid valley, have experienced frequent serious flooding. Flooding problems in these urbanized areas are mostly related to overflows from Río Nigua.

Some 3,022 families in the detailed study area would be affected by the 100-year flood event. In addition, 250 commercial structures; dozens of public buildings (particularly schools); roads, power, water, sewer, and communications utilities; and hundreds of industrial and commercial establishments will experience considerable flooding.

2. Storm tide flooding. The FEMA Flood Insurance Map for the study area depicts the sector of Playa de Salinas as being subject to floods produced by hurricane tides. A 1 percent chance exceedance storm event (100-year) is associated with a tide of 2.19 meters (NGVD). For an urban area with a ground elevation that varies between 1.4 to 1.9 meters a storm of this magnitude would have a significant impact on the entire area. However, damages from storm tides are associated with events less frequent than the two percent chance exceedance probability (50-year). Expected annual damage for Playa de Salinas associated with the storm tide flooding developed by FEMA is estimated at about $17,000. This estimate was developed using stage-damage relationships developed for riverine flooding and includes potential impacts to residential, commercial, public, and non-profit facilities. Historical records of damages due to storm tides are not available. However, although several hurricanes have passed through the island of Puerto Rico during this century, only some lower areas along the coastal line have been occasionally affected by storm tides. A detailed hurricane evacuation plan for the south coast of Puerto Rico was prepared and published by FEMA and the U.S. Army Corps of Engineers in July 1993. The plan coordinates local and Federal agencies efforts prior to major flooding events. The study effort herein documented did not address

alternatives to protect Playa de Salinas from storm tide flooding. However, the plan formulation process avoided negative impacts to current storm tide flooding conditions.

3. Historical floods. Historical floods in the Río Nigua basin have significantly affected the urban areas of the detailed study area. Since the turn of the century there have been seven major floods. In January 5-6, 1992, thunderstorms associated with a quasi-stationary cold front northwest of Puerto Rico, and an extensive area of low pressure at the surface and aloft, resulted in substantial amount of rain over the island. Rainfall amounts over the interior and south portions of the island were in the 20 to 30 centimeters range with up to 50.8 centimeters reported at several locations. This intense rainfall resulted in severe flash floods and river flooding across Puerto Rico except the northwest portion. The flooding resulted in 23 fatalities, 2 of which were in the Coco community within the Río Nigua basin. Several of the deaths occurred when residents drove past police and civil defense barricades in an attempt to return home for Three Kings Eve, Puerto Rico's most celebrated holiday. Total damage throughout the island was placed at $88 million. Most of the damage was to bridges and roads. Detailed information on this event was published by the NOAA, Natural Disaster Survey Report, Puerto Rico Flash Floods, January 5-6 1992.

The most severe in the modern history of the Río Nigua basin occurred during the period of October 5-10, 1970. The depth of water throughout most of the town was about 1 meter above ground. This flood was outstanding because of its duration and multiple peaks. It was caused by a slow-moving and sometimes stationary tropical depression. The storm struck in the form of prolonged rains over a 6-day period. Extensive damage occurred in the eastern two-thirds of the island. The zone, including some 51 municipalities, was declared a disaster area by the U.S. President. At least 16 lives were lost. Thousands of homes were damaged or destroyed and about 12,000 people were evacuated to shelters. Damage to bridges, highways, public structures, and farmlands was reported to be about $65 million. The PR Highway 1 between Ponce, Salinas, and Guayama was closed for nearly three weeks. This flood event is documented in The Floods in the Salinas Area, Atlas HA-447, U.S. Geological Survey, published in 1971.

At least four major storms have inundated the town of Salinas and its vicinity previous to the 1970 event. The worst known flood occurred in September 1928 associated with Hurricane San Felipe. The extent of the flood prone area associated with this event is depicted in Figure 3. Other floods struck in September 1933, August 1956, October 1970, and September 1975 (Hurricane Eloísa).

4. Historical damages. The Municipal Civil Defense provided limited data for the most recent floods occurring during May 24, 1992, January 5, 1992, and September 18, 1989. The Civil Defense is not responsible for collecting damage data or keeping records of historical damages but of providing emergency relief services to the victims of flooding. Damage to the agriculture, industries, and structural damage to residences, municipal buildings, commercial outlets were not reported. A review of the discharges associated with the January 5, 1992, flood shows that this flood had an estimated recurrence interval of about 5 years. Historical damage estimates for the

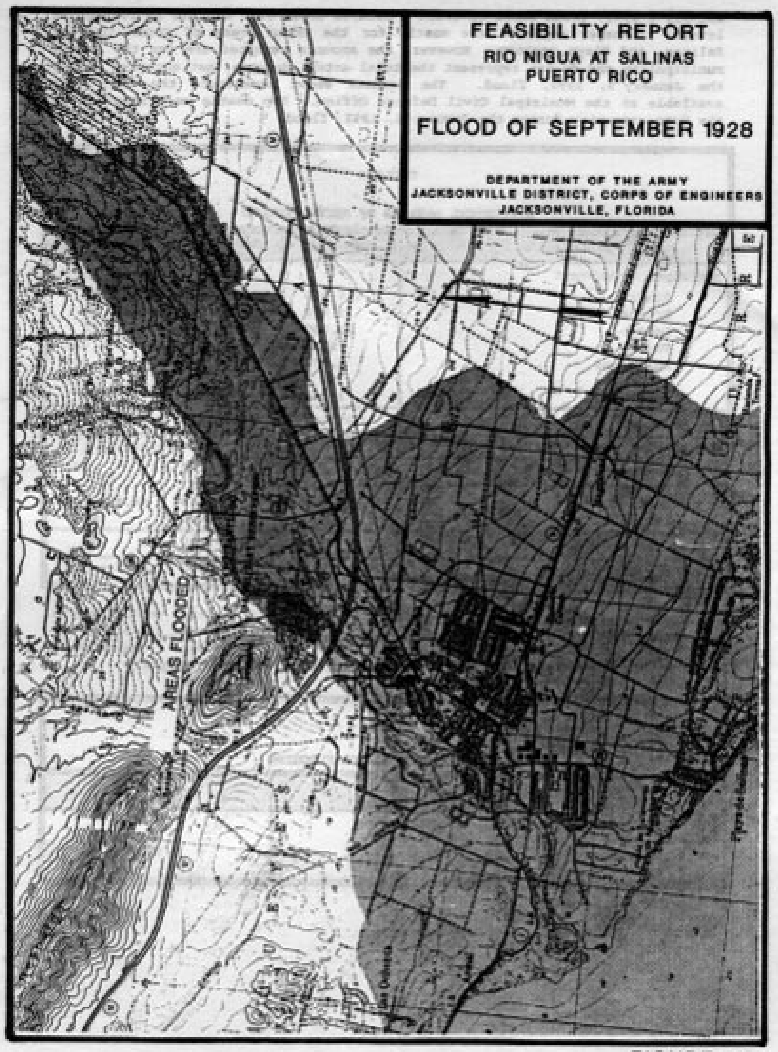

FEASIBILITY REPORT
RIO NIGUA AT SALINAS
PUERTO RICO
FLOOD OF SEPTEMBER 1928
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
AREAS FLOODED

FIGURE 3

January 5 1992, flood shown on Table 3 totaled about $9.7 million in 1992 price levels. Damages reported are mostly for the urban areas of Coco, town of Salinas, and Playa sectors. However, the amounts reported are for the entire municipality and do not represent the total actual damages that occurred during the January 5, 1992, flood. The amounts shown constitute the only data available at the Municipal Civil Defense Office. Two deaths were reported in the Coco community during the January 5, 1992, flood.

TABLE 3

HISTORICAL DAMAGES OF RECENT FLOODS

DESCRIPTION	MAY 1992	JAN. 1992	SEP. 1992
Municipal Government			
Roads	$16,000	$48,000	NR
Bridges	50,000	50,000	NR
Debris	21,000	69,000	NR
Parks	NR	90,000	125,000
Buildings	4,000	20,000	20,000
Equipment	NR	8,000	2,000
Other	1,000	NR	NR
Utilities	20,000	150,000	200,000
Residential			
Families in Shelter	3	18	304
Houses affected	32	697	757
Contents	$15,000	$8,400,000	$4,435,000
Vehicles	NR	$375,000	NR
Commercial Contents	NR	$450,000	NR
TOTAL DAMAGES REPORTED	**$127,000**	**$9,660,000**	**$4,782,000**

5. Floodable areas. The floodable areas for existing conditions in the detailed study area are shown on Plate 1. Table 4 summarizes the number of structures subject to flooding in the detailed study area. Appendix F, Economic Analysis, provides a detailed description of affected property.

TABLE 4

PROPERTY SUBJECT TO FLOODING

LAND USE	SALINAS	COCO
Residential	2,342	680
Commercial	216	34
Public and Nonprofit	117	10

The town of Salinas, sector Playa de Salinas, and the Coco community urban areas are affected by overflow of the Río Nigua. The 100-year flood event would inundate about 625 acres of urbanized areas (only 50 acres of this total are located on the west bank), 32 acres of undeveloped urban land, 248 acres of agricultural land, and about 50 kilometers of streets and highways. Most of the urban areas affected are residential, commercial, and public facilities. A total of 3,022 residential structures are located within the flood prone area. About 250 commercial establishments and some 76 public and nonprofit facilities are within the flood prone area. Under existing government regulations, all the urban area, to include the area with a logical potential for development, is under very restraining conditions due to the current flooding classification. The entire town of Salinas and the sector Playa de Salinas are within the river's floodway zone. In addition, utilities worth $1,200,000 and an entire industrial park comprising 16 buildings are also affected by flooding.

6. Potential flood damage. Risk and uncertainty analysis was incorporated to study process for sizing and reliability of recommended levee structures for the town of Salinas and Playa de Salinas, and for the levee at Coco community. Errors and uncertainties are intrinsic to flood control project. Measurement errors and complex physical, social, and economic parameters are main sources of inaccuracy. A risk-based analysis is designed to assist in the plan formulation process by accounting for errors in flood damages estimates by developing a probability distribution for the expected annual flood damages and for the benefits (damages reduced) associated with an existing or proposed project. One of the end results of this process is to identify the levee size (structure's basic crest elevation) that will maximize net benefits. In accordance with this analysis, the expected annual damage for the existing conditions within the town of Salinas to include Playa de Salinas is $1,152,400. The risk-based analysis, south from PR Highway 52, was concentrated on the town and Playa de Salinas located along the east bank of the Río Nigua. On the west bank, along PR Highway 1, there are several small clusters of residential and commercial land uses. This includes a community known as Las Ochenta. Flooding on the west bank has an impact on some 78 residential structures, 23 commercial and 2 public facilities. Expected annual damage along the west bank of the Río Nigua is estimated at $29,000. For the Coço community the expected annual damage is $1,700,400. Within the Río Nigua flood plain most of the damage is sustained by residential developments. A detailed description of risk-based analysis study efforts is included in Section IX.C.

7. Flood warning system. The P.R. National Civil Defense currently operates the Automated Local Evaluation in Real Time (ALERT), a flash flood warning system installed in 18 of the largest watersheds in Puerto Rico. ALERT consists of a network of rain gages together with stage-discharge sensors throughout the island providing real time rainfall-runoff data. This data is transmitted by a satellite telemetry system which allows monitoring the behavior of selected streams with data updates every five minutes. ALERT is jointly operated by the Civil Defense, the U.S. National Weather Service, and the U.S. Geological Survey (USGS) Water Resources Division.

In addition to the ALERT system, there are parallel (back-up) systems operated by USGS and by the DNER that cover areas not included in the main system. In the Río Nigua basin there are two sensors from this parallel system. A flood control project in the flood plain would have no adverse impact on these warning systems. The warning systems could be utilized to complement proposed flood control measures for the study area.

B. Water Supply

The Puerto Rico Aqueducts and Sewers Authority (PRASA) is a public corporation responsible for providing water and sewer service for the existing and future domestic, commercial, and industrial demand in the island. PRASA provides water to meet existing demands through the use of ground water sources. Existing sources seem to be adequate to meet future water demands.

C. Land Use

Existing development regulations associated with the flooding conditions have imposed strong restrictions and considerably limited the growth of the urban areas and commercial activity within the town of Salinas and its vicinity. The regulations controlling development in the floodway are a barrier that have limited the socioeconomic growth of these populated areas. Urban growth has spread to areas along PR Highways 1 and 3 away from the urban core and built-up areas. This creates a problem for the providers of public works services.

As population increases in the future, the demand for additional lands for development would significantly increase. The Puerto Rico Planning Board (PRPB) intends to accommodate this development by increased densification in the already developed areas and by permitting additional developments away from the floodable area. To support or encourage increased densification, the flooding condition of the area needs to be addressed.

D. Sediments

About 96 percent of the Río Nigua basin is partially covered with vegetation. This reduces the potential sediment runoff into the main channel. Most of the soils within the flood prone area appears to be stable except within the main channel where there is little vegetation. Outside the effective channel flow area the erosion and deposition activity should be minimal. Large flooding events quickly leave the main channel and move through areas covered by vegetation and or developments. Overbank water velocities range from 0.05 to 1.17 meters per second which would be considered nonerosive.

A sediment assessment for the Río Nigua basin was prepared as part of the study efforts. Study findings and recommendations are included in Appendix A, Hydrologic and Hydraulics.

E. Recreation

A variety of recreation opportunities currently exist in the proposed project area. Several beaches for swimming in the Salinas area attract the general public. There are athletic fields within easy travel distance, there is fishing in the streams near their confluence with the ocean and private recreational facilities are available.

VI. PLAN FORMULATION RATIONALE

A. General

Plan formulation involves the identification, analysis, and evaluation of alternative flood control management plans that address the planning objectives within a set of constraints, assumptions, and criteria.

This report analyzes flood control alternatives for the town of Salinas to include the sector of Playa de Salinas and the Coco community. Alternatives for the two areas were examined separately.

B. Planning Objectives

It has been established that there is a critical flooding problem in the lower and mid Río Nigua basin that seriously affects the safety and well-being of thousands of families in the Municipality of Salinas. Consequently, the overall goal guiding this report is formulating flood control plans for these urban areas that will protect the lives and property of the families and will enhance the study area's economic base to sustain future economic development.

The specific objectives are:

- Safeguard the lives of the persons living within the flood plain of the Río Nigua.
- Minimize potential, financial, and personal property losses from inundation damages.
- Minimize impacts on environmental and cultural resources.
- Minimize disruption of economic and social activities.
- Enhance opportunities for further regional growth.

C. Planning Constraints

Several environmental and physical features in the flood plain pose limitations to the type and alignment of flood control works that could be considered. The plan formulation process was framed by the following conditions:

- Most of the urban area to be protected (92 percent) is on the east bank of the river.

- There are about 30 families located on the west bank, in the vicinity upstream of PR Highway 1, that are encroaching on the river's floodway. They are located between the river channel and the town's cemetery walls.

- The PR Highway 1 bridge over Río Nigua has limited hydraulic capacity.

- Proximity of urban development to existing river channel. Under existing government regulations, the town of Salinas is located within the river's floodway.

- Under existing conditions, the PR Highway 52 east embankment (upstream side) shows signs of a significant level of erosion problems.

- South from the PR Highway 1 bridge, about 250 meters, there are railroad tracks that are no longer in use. The railroad bridge structure over Río Nigua is in very bad conditions and represents a safety and flood hazard.

- The estuarine area of Río Nigua contains a significant amount of valuable environmental resources and wildlife habitat. This area was designated as a Coastal Barrier Zone.

- Applicability of nonstructural measures to provide protection to existing developments is impaired because most of the construction is in concrete, high urban density, and costly real estate.

- A significant number of archeological and historical sites have been identified within the lower valley.

D. Planning Assumptions and Criteria

Several engineering and economic assumptions and criteria were established to guide the plan formulation and evaluation process.

1. Engineering

a. Plans were developed separately for the town of Salinas to include the sector Playa de Salinas (downstream PR Highway 52) and for the Coco community (upstream PR Highway 52). Each plan must be complete in itself.

b. Bridge structure at PR Highway 154, main access to Camp Santiago (military training area), is an obstacle to river flow. The relationship between replacing this bridge with a more efficient structure and the potential savings in the proposed levee alternative to protect the community was studied. It was concluded that replacing the bridge at the PR Highway 154 has no significant impact on water stages on the 4 kilometers reach along the Coco community.

c. PR Highway 52 divides the flood plain into two areas. The town of Salinas and Playa de Salinas are on the south (downstream) side while the Coco community is on the north. During significant flooding events the expressway will act as a levee with four openings. Flooding events of 10 years or less will pass the entire flow through the PR Highway 52 bridge opening over Río Nigua. However, for events with a lower exceedance probability (25-year flood) flooding waters upstream PR Highway 52 will also reach the town through other openings.

d. PR Highway 52 east bridge abutment is an integral part of the flood control alternatives. Bridge embankment will be protected against scour and erosion.

e. About 400 meters downstream from PR Highway 52 bridge, there is a ford that is currently providing access to a commercial quarry and a therapeutic community for drug addicts. This ford will be removed as part of the project. The sponsor requested that an alternate access be provided within lands required for the recommended plan. A new bridge structure is not under consideration.

f. Based on the sediment assessment for the study area, project conditions would have no significant impact on existing channel's deposition and erosion rate. No debris basin will be required.

g. The design flood is based on most probable future hydrologic conditions.

h. Proposed plans should minimize induced flood damages in areas outside the range of the flood control work.

i. Earthen levees were designed to have an alignment which would minimize real estate requirements, and adverse impacts to environmental and cultural resources in the area.

j. Gabion mattress armoring was considered for the levee side slopes in areas where high flow velocities are expected.

k. Flood control measures were laid out to minimize impacts on wetlands, particularly the areas in the vicinity of river estuary.

l. Risk-based analysis using selected hydrology, hydraulics, and economic variables was applied to determine optimum scale of the plan of improvements and the hydraulic performance of the plans.

2. Economic and financial

a. Plans are evaluated separately for the town of Salinas to include Playa de Salinas and the Coco community. Each plan must be justified in itself and each separate element of a plan must be incrementally justified.

b. For purpose of optimization of net National Economic Development (NED) benefits, risk and uncertainty analysis was incorporated as part of the study efforts.

c. Preliminary alternative plans for the town of Salinas were evaluated (screened) based on a comparative analysis of project cost against the expected annual damage for the with project conditions. Once a final plan was selected, the risk-based analysis was used for levee sizing and estimate structure's reliability. Preliminary alternative plans were designed to provide same level of protection (the one percent chance flood). For purpose of screening, it was assumed that alternative plans provide full flood protection.

d. Preliminary and final plans were developed reflecting 1995 price levels. The recommended plan reflects 1996 price levels.

e. Interest rate used is 7 5/8, and study period is 50 years.

E. Without Project Conditions

The without project conditions scenario would be equivalent to the no action plan, which envisions no flood control works within the detailed study area.

Potential flood hazard to the life, health, and property of the residents in the area would remain as the most critical water-related problem. Periodic disruption of productive economic activities resulting from flooding in the area would impair further economic development.

Following the present trend, the population of the municipality of Salinas is expected to increase from about 28,300 inhabitants in 1990 to about 30,400 inhabitants by the year 2005.

In terms of economic development, the future growth of the study area would depend on the success of the Commonwealth and municipal government programs to induce higher capital investment in agriculture, manufacturing, and trade. However, these efforts need to be related to the existing flooding conditions that is imposing limitations to changes in land use. Some factors that impact on future economic development in the area are the new local Industrial Incentives Act, low interest rates, the stability of crude oil prices, and the preservation of tax benefits under Section 936 of the United States Internal Revenue Code or similar Federal Tax incentive program.

The manufacturing, agriculture, and government activities are expected to remain as the most important source of income and employment in the region. The construction sector is also expected to make a significant contribution to future economic development. The existing highway network, new housing developments, shopping malls, fast food centers, and the expansion of existing facilities and infrastructure would contribute to the growth of the region. PR Highway 53 expressway is under construction and should increase in a significant way land communication capabilities between all the municipalities within the south-east, east, and North-east coast of Puerto Rico.

VII. PRIOR STUDIES AND REPORTS

Few flood control studies have been undertaken within the Río Nigua at Salinas basin. The most previous comprehensive study in the area was conducted as a cooperative effort between the Government of the Commonwealth of Puerto Rico (Department of Natural and Environmental Resources) and the U.S. Army Corps of Engineers (USACE) in 1979. The report presents results and recommendations that are relevant to the plan formulation and evaluation presented in this feasibility report.

In September 1979, the Ponce Regional Water Resources Management Study was published under the authority of Section 204 of the River and Harbor and Flood Control Act of 1970 (PL 91-611). The study provided alternative water resources management plans to meet the future needs and goals of the Ponce Region. The study covered water supply, wastewater management, flood control, recreation, environmental enhancement, and hydroelectric power potentials. The Río Nigua at Salinas basin was included in the study. The report includes preliminary flood damages estimates based on USGS 1:20,000 topographic maps with 1 to 10 meters contour lines. Average annual damages associated with floodings in the town of Salinas and Playa de Salinas were estimated at about $531,500 in 1976, and projected to increase to about $953,600 by 2035. Average annual equivalent damages were estimated at about $879,300. Flood control alternatives considered included a multipurpose reservoir in the Río Majada subbasin. All cost estimates were based on 1975 prices at an interest rate of 6 3/8 percent. The report presents a total estimated first cost of about $22 million for a flood control alternative that included a reservoir with total estimated annual cost of $1.5 million. The estimated construction cost for the flood control reservoir was $12 million with a storage capacity of 12,400 ac-ft. At present, the USACE is constructing a flood control project that includes two reservoirs in the city of Ponce. The Cerrillos Dam with a capacity of about 48,000 ac-ft has a price tag of about $200 million. The Portugués Dam, with a capacity of about 24,000 ac-ft, has a tag of $120 million. Using this experience with the real world, the Río Majada reservoir could have a price tag of about $57 million (1995 price levels). This information provided basic rationale for not considering a flood control reservoir as part of the plan formulation included in this report.

In 1971 the USGS prepared a Hydrologic Investigation Atlas on floods for the Río Nigua at Salinas valley. The report depicts areas flooded during the September 1928 flood. Also, information on some historic floods was included.

On August 5, 1986, FEMA published Río Majada Basin, Flood Insurance Study. The report was developed by the USACE. The flooding conditions depicted in this report are very severe and extensive. The report also establishes a floodway zone that covers the entire town of Salinas and most of the area of community Playa de Salinas. This delineation has imposed strong development restrictions on the municipality. However, flooding conditions developed as part of this feasibility report are less severe (stages and floodable area) than the ones depicted in the FEMA maps.

VIII. FORMULATION OF PRELIMINARY PLANS

A. Identification of Relevant Measures

Four nonstructural measures and two structural measures were identified to fully or partially address planning objectives. The non-structural measures considered are flood plain management, flood insurance, temporary and permanent flood plain evacuation, and channel maintenance. Structural measures considered include floodway improvements and levee construction. Measures considered are described in the following paragraphs:

1. Nonstructural measures.

a. PRPB Regulation 13. The most important and relevant nonstructural measure to regulate development in the flood plain is the P.R. Planing Board (PRPB) Regulation 13. This regulation, which predates FEMA flood plain regulations and which in 1987 was revised to make it consistent with FEMA, regulates all new developments and expansion of, or improvements to, existing developments in flood prone areas. For a developer to receive a construction permit in a flood prone area he must establish through a hydrologic and hydraulic study that his project is above the 100-year flood event or that it will not raise water stages in the vicinity within the urban area by more than 0.3 meters. Flood plain management regulations are assumed to be in effect under all plans. Flood plain management, however, will have very limited effect in reducing potential flood damages to existing developments.

b. Flood insurance program. The National Flood Insurance Program (NFIP) is administered by the Federal Flood Insurance Administration (FIA), which is part of FEMA. The PRPB serves as the local coordinating agency for the Flood Insurance Program in Puerto Rico. Puerto Rico entered the Emergency Flood Insurance Program (EFIP) in 1972 and entered the Regular Flood Insurance Program in 1978. For purposes of the Flood Insurance Program, Puerto Rico is considered a single community.

Flood insurance would not reduce or eliminate the flooding problem, but it would serve to reimburse property owners for losses incurred. The measure, however, seems to have been of very limited acceptance in Puerto Rico. Due to frequent and significant flood damages, insurance premiums tend to be high. However, participation rate is expected to increase because the insurance is an important requisite for any economic transaction that would relate to Federal funds.

c. Temporary and permanent flood plain evacuation. Temporary evacuation of persons and personal property from flood prone areas could be accomplished when a flood threat exists. Temporary evacuation can be very effective when operated in conjunction with a reliable flood warning system and where mobile, damageable objects are a significant portion of personal property.

The ALERT system described in section V.A.7. is currently in operation for the Río Nigua basin and would be utilized to complement proposed flood control measures for the study area.

Permanent evacuation of the flood plain areas could be used to reduce flood damage potential. Such a measure involves land purchase, physical removal of buildings and infrastructure, and relocation of population. Lands acquired in this manner could be used for parks or other purposes that would not interfere with flood flows or receive material damage from floods. However, permanent relocation of the entire town of Salinas, the Playa de Salinas sector, and most of the Coco community was not considered as part of the feasibility study. The relocation of over 3,000 families and hundreds of commercial, public, and nonprofit facilities would upset by far benefits associated with the action.

d. Stream clean out program. This measure primarily consists of removal of trash, debris, and sediments from the existing stream channel. Though minimal, this measure contributes to all objectives, especially for high frequency floods. This should be a recurring activity every two years.

2. Structural measures

a. Floodway improvements. Since this is very effective at reducing flood damages, this type of measure was considered for the town of Salinas area. However, the use of concrete lining in an environmentally sensitive area, like the river estuary, represents a significant adverse impact beyond economical considerations. Therefore, concrete channels in the lower valley were not considered.

b. Levees. This measure precludes floodwater from entering flood prone areas. Since they have proved to be very effective in areas where there is enough open space to accommodate them, without impacting significantly areas on the unprotected side of the levee, this measure was considered for both urban sectors within the detailed study area.

B. Description and Evaluation of Preliminary Plans

1. General. Preliminary flood control plans were developed separately for the town of Salinas to include Playa de Salinas and Coco community. In the case of the town of Salinas area, three plans, each designed to contain (using mean values of discharge and stages) the one percent chance exceedance flooding event (100-year), were examined. The first plan considers a long levee on the east bank of the river from PR Highway 52 all the way to the coastal area. The second plan considers a levee, also on the east bank, from PR Highway 52 to about 255 meters upstream the coastal line with a second levee along the northern fringe of the developed area in Playa de Salinas. The last plan consists of a floodwall system providing protection to the entire flood prone area south from PR Highway 52. In addition, floodway improvements along Río Nigua, to improve channel conveyance in selected areas downstream PR Highway 52, were considered. For the Coco community two levee plans were considered using the one percent chance exceedance flood (mean values) for design and cost estimates as the most relevant flood control alternatives.

For comparative, acceptibility, feasibility, and consistency with local regulations purposes, all preliminary plans considered assumed the one percent exceedance probability level of protection. Once the most relevant acceptable and effective preliminary plan for each of the areas was identified, the final sizing of the plan was accomplished through a risk-based analysis.

2. Description of Preliminary Plans

a. Town of Salinas and Playa de Salinas

(1) Plan S-1. The plan consists of 2.9 kilometers of levee, diversion channel, and floodway improvements to provide flood protection to developed areas on the east bank downstream PR Highway 52. This plan would protect the town of Salinas and Playa de Salinas. The levee would extend from PR Highway 52 to the south along the developed area on the east bank to end east from the mouth of the river to avoid the coastal barrier zone. Proposed diversion channel would help convey large flows into the sea, and it would be located east of the existing outlet of Río Nigua. A weir would be located between the river and the proposed diversion channel (downstream from PR Highway 1) to allow lower flows to continue to the existing outlet. Floodway improvements from PR Highway 52 to proposed diversion are also included in this plan. Erosion and scour protection measures would be included along the east bank of the river, diversion channel, and along the levee. Revetment would also be provided at the junction of the river and the diversion channel. The railroad bridge along with the ford would be removed. The PR Highway 1 bridge would be replaced.

The total first cost of this plan is $15.55 million with annual cost of $1.28 million, annual inundation reduction benefits of $1.15 million, and a benefit-to-cost ratio of 0.90/1.0.

(2) Plan S-2. This plan considers a levee, diversion channel, and floodway improvements similar to Plan 1 but the levee would not extend to the coastal line. The levee along the east bank of the river does not provide protection for the developed area known as Playa de Salinas. Nor does it protect the agricultural lands southeast from the town of Salinas. The levee would end about 255 meters upstream from the coastal line. The sector of Playa de Salinas would be protected separately by a ring levee of about 2.68 kilometers long with no revetment required.

The total first cost of this plan is $17.18 million with annual cost of $1.42 million, annual inundation reduction benefits of $1.15 million, and a benefit-to-cost ratio of 0.81/1.0.

(3) Plan S-3. This plan consists of concrete flood walls along both river banks following similar alignment as Plan S-1. This plan would provide flood protection to the entire flood prone area downstream from PR Highway 52. The plan provides protection to the developed sector on the west bank along PR Highway 1. Like Plan S-1, the plan also considers a diversion channel and floodway improvements. To allow high frequency flows toward the mangrove area within the mouth of the river, the plans include a culvert structure in the vicinity of the weir upstream the diversion channel.

The total first cost of this plan is $34.49 million with annual cost of $2.82 million, annual inundation reduction benefits of $1.18 million, and a benefit-to-cost ratio of 0.42/1.0.

b. Coco Community

(1) Plan C-1. This plan consists of a levee about 4.2 kilometers long to provide flood protection to the Coco community, north from PR Highway 52. The levee would begin on the east side of PR Highway 1 at a ground elevation of 50 meters NGVD, just north of the community. The levee would cross the highway to continue south along the west side of Highway 1 for about 3.4 kilometers. A ramp would be provided where the levee intersects Highway 1.

The total first cost of this plan is $4.41 million with annual cost of $0.38 million, annual inundation reduction benefits of $1.70 million, and a benefit-to-cost ratio of 4.52/1.0.

(2) Plan C-2. This plan considers a similar levee as Plan C-1, but the levee would remain parallel and west of PR Highway 1 for its entire length of about 4.10 kilometers.

The total first cost of this plan is $4.22 million with annual cost of $0.36 million, annual inundation reduction benefits of $1.70 million, and a benefit-to-cost ratio of 4.72/1.0.

3. Evaluation of Preliminary Plans

All of the preliminary plans considered for the study area would result in some beneficial and some adverse impacts on the environmental and cultural resources of the area. The final plan formulation process would investigate means to mitigate for any adverse impacts on the area's resources.

The most significant impacts deriving from the implementation of the preliminary plans would be those associated with the human, physical, and economic activities of the urban environment. These impacts relate to the protection of human lives and property from flooding and the sense of security granted to the residents within the study area, the changing of strips of natural vegetation along Río Nigua into an environment of levees, and the support of a more attractive and productive economic environment. The implementation of the plans, on the other hand, would require the allocation of substantial economic capital resources that could be used to meet other social needs.

Generally, four types of environmental impacts would be associated with the implementation of the preliminary plans discussed above. During construction there would be some temporary impacts on air quality, water quality, and aquatic life and some permanent impact to wetlands (particularly the levee along Playa de Salinas) in the area from clearing of vegetation and excavation for the construction of levees, transportation of fill materials, and realignment of existing river channels in the vicinity of the project areas. Construction of the project would also entail considerable disruption of traffic and social inconveniences because the project requires the replacement of PR Highway 1 bridge within a highly urbanized area.

In the town and Playa de Salinas area, during flooding events, the river provides an inflow of freshwater to the mangrove forest at the estuary. Plan S-3 would disrupt that function by isolating the marsh from overflow of the Río Nigua. This plan would also enhance several hundreds of acres of lands on the west bank for which there will be a tremendous pressure from the private sector for development. Plan S-3 provides protection to Las Ochenta community and other developed sectors along PR Highway 1. However, the increase in annual benefits ($29,000) are upset by the increase in project cost ($1.4 million). Plans S-1 and S-2, on the other hand, avoid these adverse impacts on the west bank. Plan S-1 would provide flood protection to about 248 acres of agricultural lands that are being converted from sugar cane to cash crops and vegetables. The P.R. Department of Agriculture, in coordination with private owners, will continue use of these lands for agriculture. Protection to this agricultural activity would yield an estimated annual benefit of about $113,300. Plan S-2 reduces the amount of agricultural land protected. In addition, the plan would have significant impacts on wetlands on the north-east sector of Playa de Salinas. Although a mitigation plan for alternative plan S-2 was not developed, this alternative is about $1.6 million more expensive than extending the town levee to protect Playa de Salinas (plan S-1).

For the town and Playa de Salinas area, a more cost effective flood control alternative was developed as part of the final plan design and evaluation process using plan S-1 as the basis.

In the Coco community area, proposed levee parallel to PR Highway 1 represents the most effective flood protection alternative.

Tables 5 and 6 summarize the most significant impacts associated with the implementation of each of the preliminary plans for the town of Salinas and Coco community detailed study areas.

On the basis of this analysis, Plan S-1 in the town of Salinas and Playa de Salinas area and Plan C-2 in the Coco community area were selected for final plan formulation.

IX. DESCRIPTION AND EVALUATION OF FINAL PLANS

A. General

The most attractive preliminary plan for the town and Playa de Salinas area, Plan S-1, was modified and then developed into a final plan for purpose of incorporating risk and uncertainty analysis to identify the NED plan through the levee-sizing process. Design and cost estimates were computed for three different levee crest elevations to develop a cost curve for the risk-based analysis. The best preliminary plan for the Coco community, Plan C-2, was also examined for different levee stages for the area north of PR Highway 52.

TABLE 5

COMPARATIVE ANALYSIS OF PRELIMINARY PLANS
(All Dollar Figures are as of 1995)

TOWN AND PLAYA DE SALINAS

DESCRIPTION	PLAN S-1 (100-Year)	PLAN S-2 (100-Year)	PLAN S-3 (100-Year)
I. National Economic Development Effects			
A. Value of Increased Output of Goods and Services (Annual)			
Inundation Reduction Benefits	1,152,400	1,152,400	1,181,400
B. Value of Resources Required for the Plan			
Total Investment Cost	15,920,439	17,594,972	35,645,740
Annual Cost	1,279,978	1,415,927	2,822,497
Annual Benefits	1,152,400	1,152,400	1,181,400
Net Benefits (Annual)	(127,578)	(263,527)	(1,641,097)
Benefit/Cost Ratio	0.90/1.0	0.31/1.0	0.42/1.0
II. Environmental Effects			
A. Cultural	Potential impact on cultural sites.	Same as Plan 1.	Same as Plan 1.
B. Flora and Wetlands	Project impacts are negligible.	Levee at Playa de Salinas will impact wetland areas.	Pressure for development vacant land on west bank.
C. Land Development	Avoids enhancing floodable lands on the west bank for future development.	Same as Plan 1.	Would enhance hundreds of acres of agricultural lands.
D. Federal Threatened and Endangered Species	No impact to endangered species.	Same as Plan 1.	Same as Plan 1.
E. Noise	Temporary noise level increased.	Same as Plan 1.	Same as Plan 1.
F. Water Quality	No impact to water quality.	Same as Plan 1.	Same as Plan 1.
Surface Water	No impact to surface waters.	Same as Plan 1.	Same as Plan 1.
Ground Water	Levee system is not expected to affect the aquifer.	Same as Plan 1.	Same as Plan 1.
III. Social Well-Being			
A. Life, health, and safety of residents	Will protect 2,342 families.	Same as Plan 1.	Will protect about 2,420 families.
B. Cohesiveness	Prevents disruption of family life.	Same as Plan 1.	Same as Plan 1.

TABLE 6

COMPARATIVE ANALYSIS OF PRELIMINARY PLANS
(All Dollar Figures are as of 1995)

COCO COMMUNITY

DESCRIPTION	PLAN C-1 (100-Year)	PLAN C-2 (100-Year)
I. National Economic Development Effects		
A. Value of Increased Output of Goods and Services (Annual)		
Inundation Reduction Benefits	1,700,400	1,700,400
B. Value of Resources Required for the Plan		
Total Investment Cost	4,553,451	4,354,300
Annual Cost	376,080	360,506
Annual Benefits	1,700,400	1,700,400
Net Benefits Effects (Annual)	1,324,320	1,339,894
Benefit/Cost Ratio	4.52	4.72
II. Environmental Effects		
A. Cultural	No potential impact on cultural sites in project area.	Same as Plan 1.
B. Flora and Wetlands	No significant impact.	Same as Plan 1.
C. Federal Threatened and Endangered Species	No impact to endangered species.	Same as Plan 1.
D. Noise	Temporary noise level increased during construction.	Same as Plan 1.
E. Water Quality	No impact to water quality	Same as Plan 1.
F. Water Supply		
Surface Water	No impact to surface waters.	Same as Plan 1.
Ground Water	No impact to ground water	Same as Plan 1.
III. Social Well-Being		
A. Life, Health, and Safety of Residents	Will protect about 680 families.	Same as Plan 1.
B. Cohesiveness	Prevents disruption of family life in the detailed study area.	Same as Plan 1.

B. Description of Final Plans

1. Town and Playa de Salinas area. In general, the plan considers a levee along the east bank of the river extending from downstream of PR Highway 52 to the coastal line. The plan includes protection measures against erosion for the east abutment of the highway bridge, where the levee would be tied to. The levee would run from PR Highway 52 to the south for about 2.96 kilometers to the coastal line east from the mouth of the river. A new bridge and ramp at PR Highway 1 would be needed to clear the levee. Upstream from PR Highway 52 the levee would continue bordering the highway's intersection with PR Highway 1 to protect the town of Salinas from flood waters entering through the opening at the bridge over Highway 1. The plan was examined for three different stages generally corresponding to different levels of protection. Table 7 shows the cost associated with each evaluated levee stage. These cost estimates represent the points in the cost curve for the risk-based analysis.

TABLE 7

COST ESTIMATE FOR DIFFERENT LEVEE STAGES
TOWN AND PLAYA DE SALINAS

($1,000 of 1995)

LEVEE CREST ELEVATION at Cross-Section 2 (mt, NGVD)	TOTAL FIRST COST	TOTAL ANNUAL COST
3.5	11,089.4	920.2
4.5	12,265.3	1,016.0
4.7	12,933.7	1,070.5

2. Coco community area. In general, the plan consists of a levee about 4.1 kilometers long to provide flood protection to the Coco community. The levee would begin on the west side of PR Highway 1 at a ground elevation of 50.3 meters NGVD, just northeast of the community. The levee would remain parallel and west of PR Highway 1 for its entire length. As in the case for the town, three different levee stages were examined.

Table 8 shows the costs associated with each levee stage.

TABLE 8

COST ESTIMATE FOR DIFFERENT LEVEE STAGES
COCO COMMUNITY

($1,000 of 1995)

LEVEE CREST ELEVATION at Cross-Section 23 (mt, NGVD)	TOTAL FIRST COST	TOTAL ANNUAL COST
38.2	4,473.2	370.2
38.7	5,322.7	437.6
38.9	5,641.3	462.9

C. Risk-Based Analysis of Final Plan

1. General. The purpose of this analysis is to incorporate risk and uncertainty (R&U) considerations in evaluating sizing and reliability of proposed flood control features for the Río Nigua at Salinas flood prone area following EC 1105-2-205. R&U analysis includes not only the expected point estimates of the most important plan formulation variables, but also a range of potential outcomes and their associated probability. Using the Monte Carlo or the Latin Hypercube simulation techniques, in which multiple iterations are done by selecting and combining inputs from the full range of possible outcomes of the various variables distributions, allow incorporation of uncertainty into the calculation of flood damages for given target stages. These target stages or elevations represent levee overtopping or failure. Uncertainty, variation, or error estimates were developed for the relationships associated with the frequency-discharge, stage-discharge, and stage-damage functions for the existing (without project) and the with project conditions. Uncertainty associated with flood protection cost was not included in the analysis. The analysis was undertaken in part with the assistance of staff from the U.S. Army Corps of Engineers' Hydrologic Engineering Center (HEC) and the Institute of Water Resources (IWR).

2. Methodology and assumptions. For purpose of this analysis, the Río Nigua flood prone area was subdivided into two reaches based on the hydrological characteristics of the flood plain. These reaches coincide with the economic reaches into which the flood plain was subdivided for economic damages analysis. The hydraulic conditions and levee design characteristics for the town and Playa de Salinas are related to each other. Therefore, for purpose of the risk-based analysis, the area downstream from PR Highway 52 was considered as one reach. Coco community was considered as a second study reach.

The proposed flood control plan would have an impact on flood stages particularly in the vicinity of PR Highway 52 during the one percent chance exceedance frequency event. Therefore, reduced expected annual damages associated with a particular levee stage were computed from the damages scenarios presented by the existing and the with project conditions stage-frequency curves and corresponding uncertainties.

Following is detailed information on data and associated uncertainty used to evaluate levee sizing for the Río Nigua at Salinas study area:

a. Discharge. Based on the basin's characteristics, a discharge-probability function was developed for the two study reaches. The proposed project would have no impact on the discharge-probability relationship. Therefore, these curves were used for the existing and the with project conditions. Statistics were computed, in accordance with Bulletin number 17B, Guidelines for Determining Flood Flow Frequency, from an adopted curve of computed discharges (HEC-1) and parallel to the regional frequency curve. Refer to section V.E.2 of the H&H Appendix. The functions were fit to a Log-Pearson Type III distribution with a logarithmic mean equal to 3.898 and 3.907 for the downstream reach and Coco community reach, respectively, and a logarithmic standard deviation of 0.406 and 0.397 for the same reaches. A regional skew coefficient of 0 was used for both study reaches. An equivalent period of record of 25 years was used to develop discharge uncertainty.

b. <u>Stages</u>. A HEC-2 model was developed for the evaluation of the existing and with project conditions. The model was calibrated with detailed information collected by the USGS from floods associated with the October 1970 tropical depression, a ten percent chance exceedance frequency event. The hydraulics of the existing conditions was used to develop the stage-discharge relationship to compute the without project expected annual damages for the reaches under consideration. For the Coco community, the with project expected annual damages were established with the same stage-discharge function due to the negligible impacts of the with project conditions. However, for the town reach, the with project hydraulics was used to compute the with project expected annual damages. Table 9 provides the stage-discharge curve developed for the without project conditions for the two reaches under consideration.

TABLE 9
STAGE-DISCHARGE CURVE

TOWN AND PLAYA DE SALINAS		COCO COMMUNITY	
Stage at Cross Section 2 (NGVD)	Discharge (cms)	Stage at Cross Section 23 (mt, NGVD)	Discharge (cms)
0.5	0	34.0	0
2.1	527	35.5	142
2.4	748	36.8	526
2.8	1389	37.8	1556
3.2	1967	38.3	2404
3.4	2834	38.8	4251
4.3	8502	39.0	7085

Uncertainty for each of the stage-discharge functions (with project and without project) for the one percent chance exceedance frequency event was determined from the comparative analysis of two approaches: (1) the values shown in the Minimum Standards Deviation Table provided in EC-1105-2-201 and (2) one fourth of the stage difference between the upper and lower bounds around the HEC-2 developed profiles for existing and the with project conditions that resulted from a water surface profile sensitivity analysis (varying "n" value) for the flood plain. The sensitivity analysis results were selected (most critical) for the computation of the standard deviation of the stage-discharge functions. Standard deviation of stage uncertainty for the one percent chance exceedance frequency event ranges from 0.20 meters within the town reach to 0.24 meters within the Coco community reach.

. <u>Damages</u>. A stage-damage curve was developed for each of the two study reaches. For the Coco community reach, a single curve consolidating all land uses was developed for the with and without project conditions. But the stage-damage relationship developed for the town reach took a significant amount of additional effort. The diversity of land uses and the changes associated to the with and without project conditions made the difference for the second reach. Two stage-damage curves were developed for the existing conditions and then consolidated into one relationship to be used in the levee-sizing process. The first curve included residential and commercial damages. The second curve included nonprofit, public, and industrial damages. The same process was followed for the with project conditions. Uncertainty was determined through a proportional random sample of 61 observations for estimating errors associated with structure and content value of residential structures within the flood prone area. In the case of commercial, public, and nonprofit facilities, the entire population was surveyed.

On the basis of past experience with FEMA's Detailed Survey Reports for residential structures, a 10 percent error of damage at each stage and a confidence level of 95 percent were assumed for the depth-damage relationship. Refer to Appendix F, Economics, for detailed information on the development of the stage-damage relationship.

d. Costs. Cost estimates including real estate costs and O&M were developed for three stages or levee heights. These cost estimates reflect 1995 price levels. Uncertainties associated with the stage-cost relationship were not considered in the analysis.

3. Procedure. The Monte Carlo sampling method for the sizing process and the Latin Hypercube sampling method for developing the stage-damage curve were used to determine expected annual damages for the with and without project conditions, by considering estimated uncertainties in the various relationships influencing the results. The number of iterations in the simulations was carried for the EAD analysis (sizing of plan) and for the reliability of the plan until the values converge to the input statistics or until no significant change in the expected values were being obtained with additional iterations.

Two risk-based analysis work sheet templates were developed with the assistance of the U.S. Army Corps of Engineers' Hydrologic Engineering Center (HEC) and the Institute of Water Resources (IWR). The first one for the economic analysis includes: the depth-damage percentage curve, mean values and standard deviations of structure, and content value for each of the different land uses within each of the reaches under consideration. About 14 points (simulations) were considered. For each stage, 1,000 iterations (using the Latin Hypercube sampling method) were run to develop the stage-damage curve with uncertainty. This curve served as an input to the second work sheet. This work sheet includes the discharge frequency curve with uncertainty and the stage discharge with uncertainty for each of the two reaches under consideration. By the Monte Carlo sampling method between 4,000 and 5,000 iterations were used to generate expected annual damage for the with and the without project conditions for each of the two reaches under consideration.

Project reliability simulations (performance) were undertaken for every stage (target elevation) associated with the various levee heights for each reach under consideration for the 1, 0.43, 0.2 percent chance exceedance probability events. This analysis provides information on percent probability of the levee containing the particular event under consideration. As in the levee sizing process, between 4,000 and 5,000 iterations were used to simulate each levee height performance.

4. Results. Tables 10 and 11 summarize the sizing and reliability simulation results for selected levee heights for the final flood control plan under consideration for the town and Playa de Salinas, and for the Coco community flood prone areas. The levee height that maximizes expected net benefits is the NED plan. The stages (levee heights) selected for the analysis represent an adequate range to identify the NED plan. As shown in Tables 10 and 11, net benefits for lower or higher stages than the NED plan would yield less benefits. Therefore, evaluating higher or lower stages than those presented would have no impact on the NED plan formulation.

The sizing portion of the risk-based analysis for the town and Playa de Salinas levee (Table 10) resulted in a levee height of 4.5 meters (NGVD). Proposed levee project for the flood prone area is expected to contain the one percent chance exceedance frequency flood (100-year) with a 99.7 percent probability. This structure would have a 0.01 percent chance of being overtopped in any given year (10,000-year event).

In the case of the Coco community levee, the sizing process (Table 11) resulted in a levee height of 38.7 meters (NGVD). Proposed levee project for the flood prone area is expected to contain the one percent chance exceedance frequency flood (100-year) with a 91.1 percent probability. This structure would have a 0.33 percent chance of being overtopped in any given year (300-year event).

D. Analysis of the Final Plan

1. General. The purpose of this analysis is to evaluate the final plan on basis of its contributions to the planning objectives.

2. Contributions to the planning objectives

a. Safeguard lives. Safeguarding the lives of some 3,022 families living along the Río Nigua flood plain in the areas of the town and Playa de Salinas and Coco community is considered the ultimate objective of the proposed flood control project. A significant proportion of this population belongs to low-middle income families striving toward improving their living conditions. The plan would contribute substantially to reduce the threat to life as a result of major floods in the study area.

b. Minimize property losses. The criterion utilized to measure contribution of the plan to this objective was reduction of inundation damages. Total expected annual inundation damages under the without and with project conditions were estimated through a risk-based analysis for each flood control plan. The plan for the area provides over 98 percent reduction of flood related damages; and in that sense, it is very effective at minimizing property losses.

TABLE 10

LEVEE SIZING
TOWN AND PLAYA DE SALINAS

			ANNUAL DAMAGES (x $1,000)[1]				
Stage[2] (NGVD) (mt)	Exceedance[3] Probability	True Exceedance Probability	Without Project	With Project	Reduced	Annual Cost	Net Benefits
3.5	0.0028	0.0079	1,152.4	331.7	820.7	920.2	(99.50)
4.5	0.0001	0.0001	1,152.4	9.2	1,143.2	1,016.0	121.2
4.7	0.0001	0.0000	1,152.4	0	1,152.4	1,070.5	81.9

RELIABILITY OF LEVEE STAGE FOR SELECTED EVENTS[4]

	FLOODING EVENTS		
Stage (NGVD) (mt.)	0.01 (100-Year)	.0043 (235-Year)	.002 (500-Year)
3.5	79.1	58.3	40.6
4.5	99.7	99.3	98.6
4.7	99.9	99.9	99.8

[1] Residential, commercial, and others.
[2] Reference to cross-section 2 (hydraulic analysis).
[3] From discharge-frequency curve (HEC-1).
[4] Probability of levee containing a particular event.

TABLE 11

LEVEE SIZING
COCO COMMUNITY

			ANNUAL DAMAGES (x $1,000)[1]				
Stage[2] (NGVD) (mt)	Exceedance[3] Probability	True Exceedance Probability	Without Project	With Project	Reduced	Annual Cost	Net Benefits
38.2	0.0061	0.014	1,700.4	133.1	1,567.3	370.2	1,197.1
38.7	0.0009	0.0033	1,700.4	32.5	1,667.9	437.6	1,230.3
38.9	0.0003	0.0013	1,700.4	12.8	1,687.6	462.9	1,224.7

RELIABILITY OF LEVEE STAGE FOR SELECTED EVENTS[4]

Stage (NGVD) (mt.)	FLOODING EVENTS 0.01 (100-Year)	.0043 (235-Year)	.002 (500-Year)
38.2	63.7	39.8	23.7
38.7	91.1	79.5	65.4
38.9	95.5	89.2	80.4

[1] Residential, commercial, and others.
[2] Reference to cross-section 23 (hydraulic analysis).
[3] From discharge-frequency curve (HEC-1).
[4] Probability of levee containing a particular event.

c. Maximizing net economic benefits. The maximum contribution to net national benefits of the plan for the town and Playa de Salinas area is about $127,000 per year. The plan for Coco community would have a net benefit contribution of about $1.23 million per year.

d. Minimize social disruption. This objective refers to minimizing adverse impacts on the normal daily economic and social life in the detailed study area. Whenever there is flooding in the area, indirect damage would result from reduction of business operations: thousands of persons unable to reach their jobs; hundreds of cars stalled in the middle of streets, avenues, and highways; recreational activities suspended; and reduction of other public services. The scope of services of agencies dealing with flood protection and relief in the areas affected (e.g. the Civil Defense, the Red Cross, etc.) is increased as well as isolation and social disruption of families. The plan under consideration requires relocation of about 30 families within the flood plain. This action should represent a substantial improvement to existing living conditions for these families.

e. Protecting the study area's environmental and cultural resources. Proposed plan would have no significant impact on the area's environmental resources. The recommended plan would provide means to satisfactorily mitigate all adverse impacts on the area's cultural resources.

X. RECOMMENDED PLAN

A. Description of Components

The recommended plan consists of a levee system (with two levee segments) to provide flood protection to the town of Salinas and the sector known as Playa de Salinas and a third levee segment to provide flood protection to Coco community (Plates 2 and 3).

The recommended plan of improvements for the Río Nigua south from PR Highway 52 consists of a levee along the east bank of the river extending from the highway down to the coastal line. The plan includes protection measures against erosion for the east abutment of the highway bridge, where the levee would be tied to. The levee would run from PR Highway 52 to the south for about 2.96 kilometers to end east from the mouth of the river. The sizing process (R&U) shows a levee crest elevation of 4.5 meters (NGVD) at cross-section 2 as the NED levee height for this area. The levee would have an average height varying from 1.5 meters in the coastal area to 5 meters in the vicinity of PR Highway 52. The structure with a minimum crest width of 3 meters and side slope of 1V:2.5H would include revetment protection on structure's floodside. The railroad bridge, no longer in use, would be removed. A new bridge and ramp at PR Highway 1 would be needed to clear the levee with a low chord elevation of 8.7 meters (NGVD). Existing top of the road elevation is about 6.9 meters (NGVD). Revetment protection will also be provided at the new PR Highway 1 bridge. There would be three drainage structures along the levee. A 1.52 mt. diameter corrugated metal pipe (cmp) culvert would be located south of the new PR Highway 1 bridge (north of the railroad tracks). Two 1.52 mt. dia. cmp culverts would be located north of the new PR Highway 1 bridge. A third drainage structure, one 1.52 mt. dia. cmp, would be located about 1 kilometer south of PR Highway 52. A road ramp would be provided south of the railroad tracks to provide access to about 60 acres of coastal lands located between the river outlet and proposed levee.

A levee segment would be required to protect the intersection between highways 52 and 1 to avoid flood waters reaching the town through the bridge opening in that area. This segment would start from the upstream side of the east abutment of the PR Highway 52 bridge following a highway access ramp and ends downstream from the highway's exit ramp to PR Highway 154. The levee location would avoid impacts to the PR Highway's 1 and 154 intersection. Gabion protection would be required along the levee floodside. The about 610 meters structure would have a maximum height of 3.8 meters with a 1V:2.5H side slope and a crest width of 3 meters.

There will be an unpaved access road starting at PR Highway 1 going north along the western right-of-way of the river channel and crossing the Quebrada Honda to tie into an existing road, located downstream of PR Highway 52. The access road is about 1.54 kilometers long with a ford crossing at Quebrada Honda. This is to replace existing ford crossing at Río Nigua about 400 meters downstream from PR Highway 52. At the present, this ford provides access to a commercial quarry and a therapeutic community.

To avoid relocating existing family dwellings, segments of the proposed levee would be located in the existing river channel. These locations are at the river's intersection with the railroad bridge (to be removed) and upstream the new PR Highway 1 bridge. The river channel would be realigned, but not deepened, at these locations to restore existing conveyance.

For the Coco community the sizing process (R&U) shows a levee crest elevation of 38.7 meters (NGVD) at cross-section 23 as the NED plan for this area. However, the recommended plan was designed with a crest elevation of 39.3 meters (NGVD). To the levee segment within section 23 a 0.6 meters of superiority was added due to the sensitivity of this particular area. Therefore, the earthen levee would have a total length of 3.98 kilometers and an average height of about 3.8 meters with a side slope of 1H:2.5V. The levee would be adequately protected with established and well-maintained grass cover. The about 32.88 acres of lands required for the levee are within the Federal Camp Santiago Military Reservation.

The recommended plan would require about 143.42 acres: 16.86 in fee, 43.68 in easements, and about 82.88 acres of Federal owned lands. Within this total there are 25 acres of disposal area and 50 acres of borrow site.

The plan would require acquisition of a farm residence in poor conditions, a radio station office building, a service station, 5 residential dwellings, and 30 family dwellings to be removed.

There are two water lines (4 and 2 inches), telephone and a significant amount of electric power lines in the vicinity of PR Highway 1 bridge that would be relocated as part of the recommended plan. Downstream from PR Highway 52, about 350 meters, there is a 130 meters long siphon (30" dia. in average) that is part of the irrigation system of the area that would be modified to accommodate proposed flood control plan.

The recommended plan is shown on Plates 2 and 3. Typical cross sections of project features and details of flood profiles for the recommended plan of improvements are presented in Appendix C, Design and Cost Estimates.

B. Summary of Impacts and Economics

Proposed plan would have an impact on flood stages in the vicinity downstream PR Highway 52. However, a taking analysis included in Appendix E, Real Estate Plan, concluded that the increased flooding caused by the project will not constitute a taking under the Fifth Amendment of the United States Constitution.

No significant natural resources would be adversely affected by the project: no threatened or endangered species, coastal barrier resource segments, wetlands areas, or significant fish and wildlife habitat would be adversely affected and, therefore, no mitigation actions are proposed.

Historic properties which may be affected by the recommended plan include the PR Highway 1 bridge, the railroad bridge, and a historical site. The project's effects on these resources will be adverse and will require mitigation. Proposed mitigation for loss of the bridges include documentation to Historic American Engineering Record (HAER) standards. Additional field work will be conducted for the archeological site.

Tables 12 and 13 summarize, respectively, the cost estimates and economic impacts of the recommended plan for each of the detailed study areas and for the project as a whole. Detailed cost estimates are presented in Appendix C, Design and Cost Estimates, while details on benefits associated with the plans are discussed in Appendix F, Economic Analysis. Table 12 provides a comparative analysis for the two sectors using only inundation reduction benefits associated with the recommended plan. Table 13 provides a complete analysis of the economics of the plan. Construction cost presented in both tables do not include PL-646 assistance payments nor cultural preservation cost. The cost figures shown in Table 12 and 13 differ from those used for risk-based analysis (Tables 10 and 11). The cost figures for the recommended plan are MCACES detailed cost estimates as of August 1996. Cost estimates for the preliminary plans were developed with generalized information collected within 1994 and 1995. In addition, MCACES cost estimates for the recommended plan includes more detailed real estate cost information.

TABLE 12

COMPARATIVE ANALYSIS FOR SEPARABLE ELEMENTS
($1,000 OF August 1996)

ITEMIZED FEATURES	TOWN & PLAYA	COCO	TOTAL
Roads and Bridges	2,373.0	0	2,373.0
Utilities and Structures	251.3	0	251.3
Levees and Floodwalls	2,919.4	2,154.6	5,074.0
Channels and Canals	633.0	0	633.0
Total Construction Cost	**6,176.7**	**2,154.6**	**8,331.3**
Real Estate	2,054.5	222.9	2,277.4
Planning Engineering and Design	596.3	216.0	812.3
Construction Management	655.0	237.6	892.6
TOTAL FIRST COST	**9,482.5**	**2,831.1**	**12,313.6**
Interest During Construction	400.8	140.7	541.5
TOTAL INVESTMENT COST	**9,883.3**	**2,971.8**	**12,855.1**
Annualized Investment Cost	773.2	232.5	1,005.7
Annual Operation and Maintenance Cost	45.5	20.5	66.0
TOTAL ANNUAL COST	**818.7**	**253.0**	**1,071.7**
Annual Inundation Reduction Benefits	**1,143.2**	**1,667.9**	**2,811.1**
Net NED Benefits	324.5	1,414.9	1,739.4
BENEFITS TO COST RATIO	**1.4/1**	**6.6/1**	**2.6/1**

Note: Real Estate cost does not include PL-91-646 Assistance Payments.
Benefits and costs amortized at 7 5/8% for 50 years.

TABLE 13

ECONOMICS OF THE RECOMMENDED PLAN

($1,000 of August 1996)

Itemized Elements	Town and Playa	Coco	Total Project
Total First Cost	9,482.5	$2,831.1	$12,313.6
Interest During Construction	400.8	140.7	541.5
Total Investment Cost	9,883.3	$2,971.8	$12,855.1
Interest and Amortization	773.2	232.5	1,005.7
Annual O&M Costs	45.5	20.5	66.0
TOTAL ANNUAL COST	**818.7**	**253.0**	**1,071.7**
Annualized Benefits			
Inundation Reduction	1,143.2	1,667.9	2,811.1
Agricultural	113.3	0.0	113.3
Employment	36.0	13.5	49.5
Flood Insurance	8.2	0.0	8.2
Advance Bridge Replacement	64.7	0.0	64.7
TOTAL ANNUAL BENEFITS	**1,365.4**	**1,681.4**	**3,046.8**
NET NED BENEFITS	**546.7**	**$1,428.4**	**1,975.1**
BENEFIT-TO-COST RATIO	**1.7/1**	**6.6/1**	**2.8/1**

NOTE: Benefits and Costs Amortized at 7.625%

Period of Analysis = 50 years

Table 14 provides cost estimates for the recommended plan for the project as a whole. Total first cost of the components of the recommended plan for the Río Nigua de Salinas study area is $12,713,600, while annual cost including interest during construction and O&M is $1,071,700. Implementation of the plan will result in NED annual benefits of $3,046,800 and a benefit-to-cost ratio of 2.8/1.0.

TABLE 14

COSTS ESTIMATES OF RECOMMENDED PLAN
($1,000 of August 1996)

DESCRIPTION	ECONOMIC COST	FINANCIAL COST
Roads and Bridges	2,373.0	2,373.0
Utilities and Structures	251.3	251.3
Levees and Floodwalls	5,074.0	5,074.0
Channels and Canals	633.0	633.0
TOTAL CONSTRUCTION COST	**8,331.3**	**8,331.3**
Real Estate	2,277.4	2,277.4
P. L. 91-646	----	340.0
Cultural Preservation	----	60.0
Planning, Engineering, and Design	812.3	812.3
Construction Management	892.6	892.6
TOTAL FIRST COSTS	**12,313.6**	**12,713.6**
Interest During Construction	541.5	
TOTAL INVESTMENT COSTS	**12,855.1**	
Interest and Amortization	1,005.7	
Annual Operation and Maintenance Cost	66.0	
TOTAL ANNUAL COST	**1,071.7**	

Notes: Figures include appropriate contingency costs. Detailed estimates are shown in Appendix C, Design and Costs. Discounted at current interest rate of 7 5/8 percent. The economic cost is related to the economic analysis on Tables 12 and 13. The financial cost is related to the project cost sharing on Table 15.

Though implementation of the plan would reduce expected annual damages in over 98 percent, there would still be about $41,700 of expected annual residual flooding damages.

The recommended plan was examined in accordance with Executive Order 11988. The recommended plan is the only practicable flood control management plan for the detailed study area. The implementation of the recommended plan would not enhance vacant lands that could induce future urban expansion on the existing flood plain area.

C. Federal and Non-Federal Cost Sharing of Recommended Plan

The Federal Government would design and prepare detailed plans and construct the project (exclusive of those items specifically required of non-Federal interests) after Congressional authorization and funding; upon signing of a contractual agreement for local cooperation as required by Section 21 of the 1970 Flood Control Act and the 1986 Water Resources Development Act; and upon completion of those items of local cooperation required prior to construction.

The local sponsor would be required to provide all lands, easements, and rights-of-way; alteration and relocation of buildings, bridges, and public utilities; to hold and save the Federal Government from damages due to the construction works; and to properly maintain and operate all works after completion of the project, including establishing and enforcing regulations, to assure the flood control project accomplishes its objectives.

Table 15 shows cost sharing of total first cost of the project as established in the Water Resources Development Act of 1986 for the Río Nigua at Salinas project area. The non-Federal costs would be those associated with easements, rights-of-way, relocation, bridge replacement or new bridges, operation and maintenance. The sponsor is also required by law to contribute five percent in cash of the flood control cost. For the recommended plan, the total project cost is estimated at $12,713,600. The sponsor will contribute $5,877,400 or 46 percent, and the Federal share will be $6,836,200 million.

TABLE 15

RECOMMENDED PLAN
COST SHARING OF TOTAL FIRST COST
($1,000 of August 1996)

DESCRIPTION	TOTAL	FEDERAL	NON-FEDERAL
FLOOD CONTROL ITEMS			
Levees and Channels	7,471.9	7,471.9	0.0
Relocation of Roads, Bridges, Utilities, and Structures	2,624.3	0.0	2,624.3
Lands and Damages	2,617.4	0.0	2,617.4
TOTAL FLOOD CONTROL COST	12,713.6	7,471.9	5,241.7
5% Non-Federal Contribution		- 635.7	+ 635.7
SUBTOTAL		6,836.20	5,877.4
25% Minimum Contribution			3,178.4
50% Maximum Contribution			6,356.8
Contribution Adjustment (not to exceed 50% maximum)		0.0	0.0
SUBTOTAL		6,836.20	5,877.4
Ability to Pay Adjustment		0.0	0.0
SUBTOTAL		6,836.20	5,877.4
TOTAL FIRST COST		6,836.20	5,877.4

The application of the ability to pay procedures for determining altered cost shares for qualifying non-Federal sponsors is specified on ER 1165-2-121. The recommended Río Nigua at Salinas flood control project does not meet the condition of the benefit test and, therefore, does not qualify for a reduction in the non-Federal share.

D. Financial Plan

During several coordination meetings with the local sponsor, the U.S. Army Corps of Engineers field office has discussed and explained the recommended plan for a flood control project for the areas of Salinas. The local sponsor understands its responsibilities for contributing with all lands, easements, and right-of-ways, relocation of bridges and utilities, and the acquisition of buildings and structures necessary for project implementation. In addition, the sponsor understands the Federal requirement for contributing a minimum of five percent cash of the total flood control first cost. Options for financing the local share of the project were also discussed. The local sponsor has expressed its support for the recommended plan and its intent to comply with all requirements as outlined in this report.

The local sponsor intends to finance the local share in the project using the same financial scheme used for the multi-million multipurpose Portugués-Bucaná project currently under construction and the upcoming Río Puerto Nuevo flood control project. Project funding will be obtained by annual appropriations from the Commonwealth Legislature for the capital improvement program for flood control works managed by the Puerto Rico Department of Natural and Environmental Resources. These funds are obtained from the annual selling of about $350 million of Commonwealth of Puerto Rico bonds which are allocated for infrastructure development. The funds, now being budgeted and programmed by the sponsor, will cover its share of the total first cost for construction of the project in accordance with this report and latest PMP. It is reasonable to expect that ample funds will be available to satisfy the non-Federal sponsor financial obligations for the project.

The above financial plan is similar to the ones that have supported recently authorized flood control projects in Puerto Rico such as Río Puerto Nuevo and Río de la Plata.

E. Coordination

The study was developed and worked out in close coordination with the Puerto Rico Department of Natural and Environmental Resources, the local sponsor; the Puerto Rico Planning Board; the State Historic Preservation Officer; the municipality of Salinas; the U.S. Fish and Wildlife Service; the U.S. Geological Survey; and the Environmental Protection Agency.

The local sponsor has read and concurs with the findings of the report and will provide a Letter of Intent supporting the report's conclusions and recommendations.

The Draft Project Cost Agreement was discussed with the local sponsor, and they generally understand and concur with it.

The local sponsor, DNER, will obtain and provide its share of total first cost for construction of project through annual appropriations from the local legislature.

F. Steps to Plan Implementation

Submission of this report by the District Engineer constitutes the first step in a chain of events that must take place before a flood control project can become a reality. It may be modified at any stage of review, and only if it successfully passes each stage, will it ultimately be constructed. These events are:

1. Review of the feasibility report and the environmental impact statement by higher Corps of Engineers authorities, including the South Atlantic Division, the Washington Policy Review Branch, and the Office of the Chief of Engineers.

2. At the request of the Chief of Engineers, formal review by the Governor of the Commonwealth of Puerto Rico.

3. Comments by other interested Federal agencies at the request of the Chief of Engineers.

4. Submission of the feasibility report and EA to the Assistant Secretary of the Army for Civil Works for review and approval.

5. Review and comment by the Office of Management and Budget regarding the relationship of the project to the program of the President.

6. Submission of the feasibility report and EA by the Secretary of the Army to the United States Congress.

7. Consideration of the feasibility report by the United States Congress and authorization in a Water Resources Development Act.

8. Inclusion in the President's budget, when appropriate, of funds for Planning, Engineering, and Design (PED) and construction of the authorized project by the Chief of Engineers.

9. Appropriation of the necessary funds by the United States Congress.

10. Fulfillment of the required measures of local cooperation including cost sharing and lands, easements, rights-of-way, and relocations.

11. Completion of the necessary surveys and investigations for the preparation of Design Memorandums to include Value Engineering evaluations, preparation of plans, specifications, and an estimate of the construction cost by the District Engineer; and acquisition of required permits followed by an invitation for bids and awarding of the construction contracts.

XI. CONCLUSIONS

The Río Nigua at Salinas Feasibility Report shows that flooding is a major problem threatening the life, property, and economic development of the residents of the Municipality of Salinas, Puerto Rico. The report shows that it is economically justified and necessary to develop and construct a flood control project for this area.

The recommended plan of improvements for the Río Nigua basin consists of 2.96 kilometers levee along the east bank of the river downstream from PR Highway 52 to provide flood protection to the town and Playa de Salinas, and a second 3.98 kilometers levee to provide flood protection to Coco community. The plan for the town of Salinas includes a 610 meters levee segment around intersection of PR Highways 52 and 1, and revetment protection along the total length of the structure. Some 3,022 families currently living in the flood plain would be protected from the overflow of Río Nigua. Total first cost of the recommended plan is $12,713,600. Net Annual National Economic Benefits are in the order of $1,975,100 and the benefit-to-cost ratio is 2.8/1.0. The recommended plan is the National Economic Development Plan. The Federal contribution for the implementation of the plan would be $6,836,200, while the non-Federal would amount to $5,877,400.

I have given consideration to all significant aspects in the overall public interest, including engineering feasibility, economic, social, and environmental effects. The recommended plan described in the report provides the optimum solution for flood protection along the Río Nigua at Salinas and its main tributaries within the framework of the formulation concepts.

XII. RECOMMENDATIONS

I recommend that the plan of improvements for Río Nigua at Salinas described in Chapter IX of this report be authorized for implementation as a Federal project, with such modifications as advisable at the discretion of the Chief of Engineers, for a total first cost to the United States estimated at $6,836,200 and a benefit-to-cost ratio of 2.8 to 1.0. The exact amount of non-Federal contributions shall be determined by the Chief of Engineers following polices satisfactory to the President and the Congress prior to project implementation. This recommendation is also subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including the following requirements:

a. Provide a minimum of 25 percent, but not to exceed 50 percent, of total project costs assigned to flood control, as further specified below:

(1) Provide, during construction, a cash contribution equal to five percent of total project costs assigned to flood control.

(2) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project.

(3) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project.

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and Commonwealth laws and any specific directions prescribed by the Government.

c. Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls full access to the project for the propose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project related betterment, except for damages due to the fault or negligence of the Government or the Government's contractors.

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project.

g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way necessary for the construction, operation, or maintenance of the project.

h. To the maximum extent practicable, operate, maintain, repair, replace and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

i. Participate in and comply with applicable Federal flood plain management and flood insurance programs.

j. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

k. Not less than once each year, inform affected interests of the limitations of the protection afforded by the project.

l. Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

m. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987, Public Law 100-17, and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

n. Comply with all applicable Federal and Commonwealth laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Direction 5500.II issued pursuant thereto and published in part 300 of title 32, case of Federal Regulations, as well as Army Regulations 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

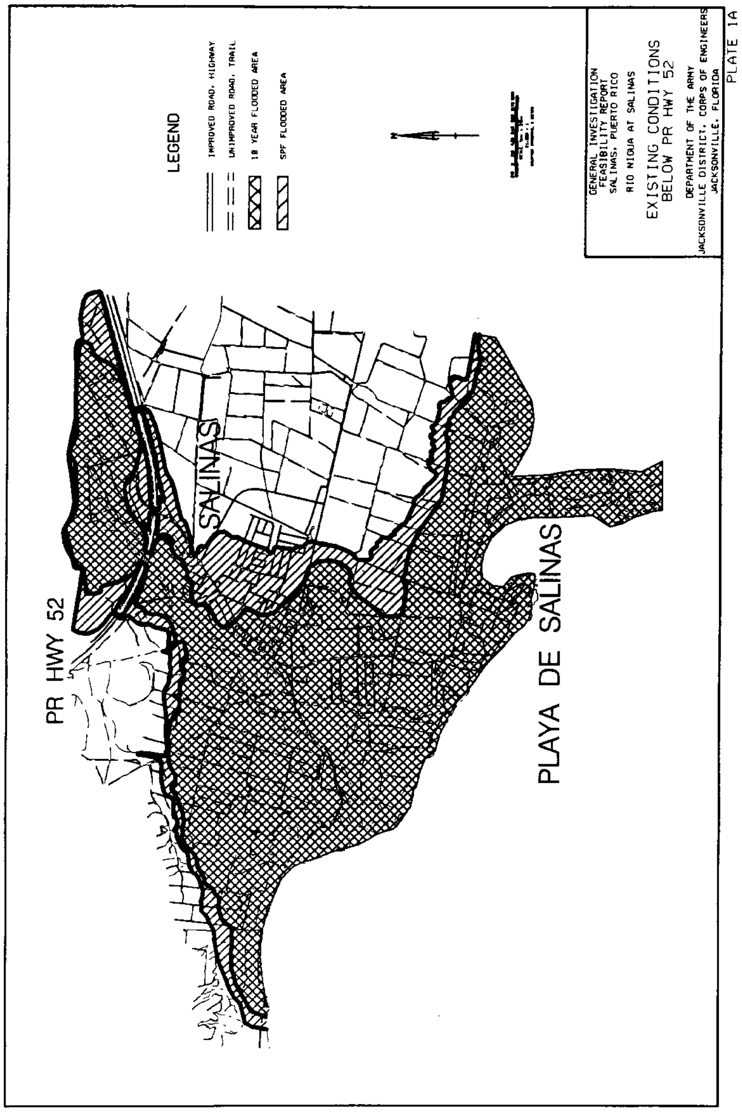
The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as a proposal for authorization and implementation of funding. However, prior to transmittal to the Congress, the sponsor, the Commonwealth of Puerto Rico; interested Federal agencies; and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

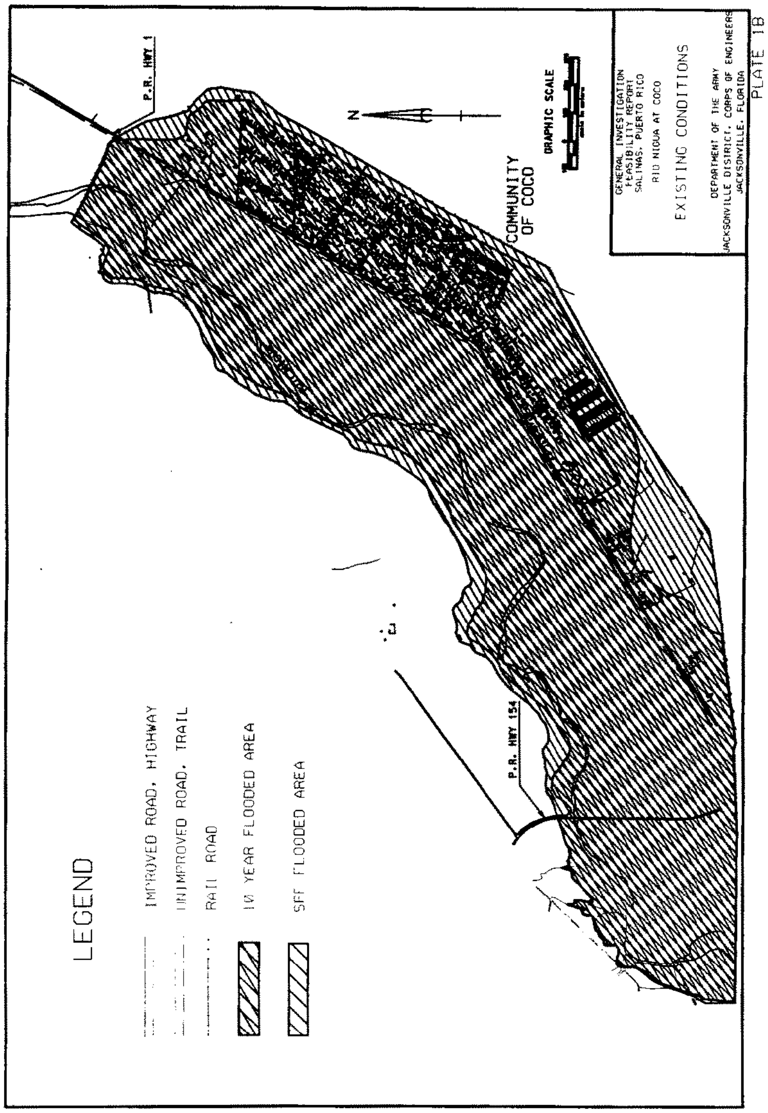
TERRY L. RICE
Colonel, Corps of Engineers
Commanding

James A. Connell
Lieutenant Colonel, U.S. Army
Acting District Engineer

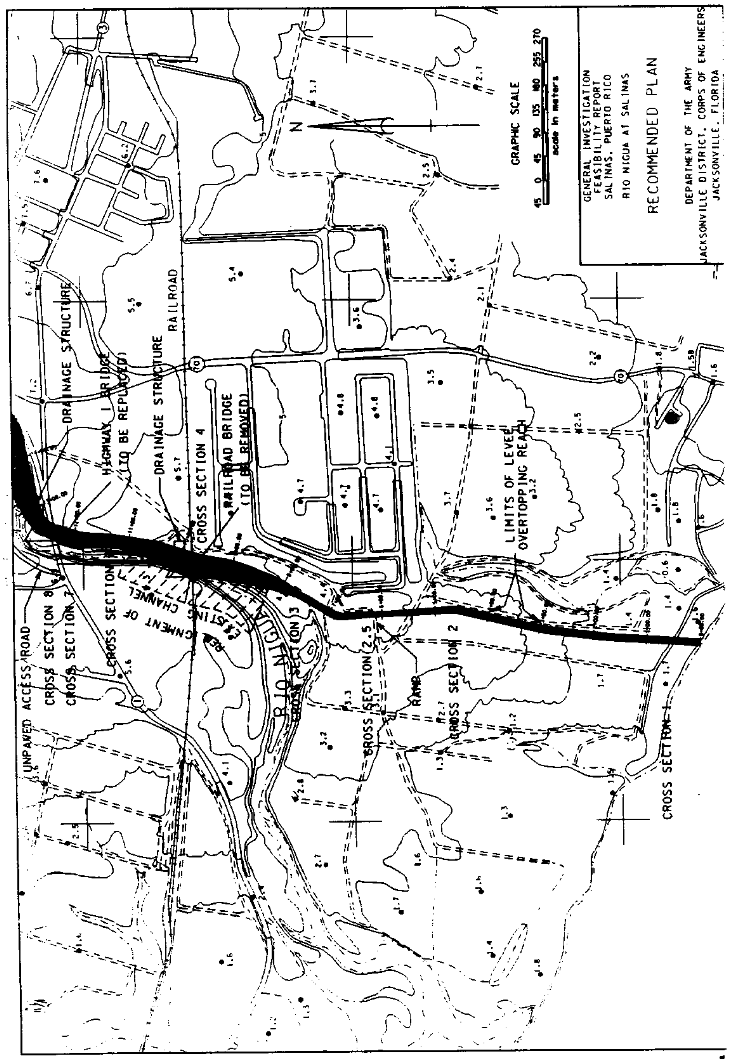
RIO NIGUA AT SALINAS FEASIBILITY REPORT
MAIN REPORT

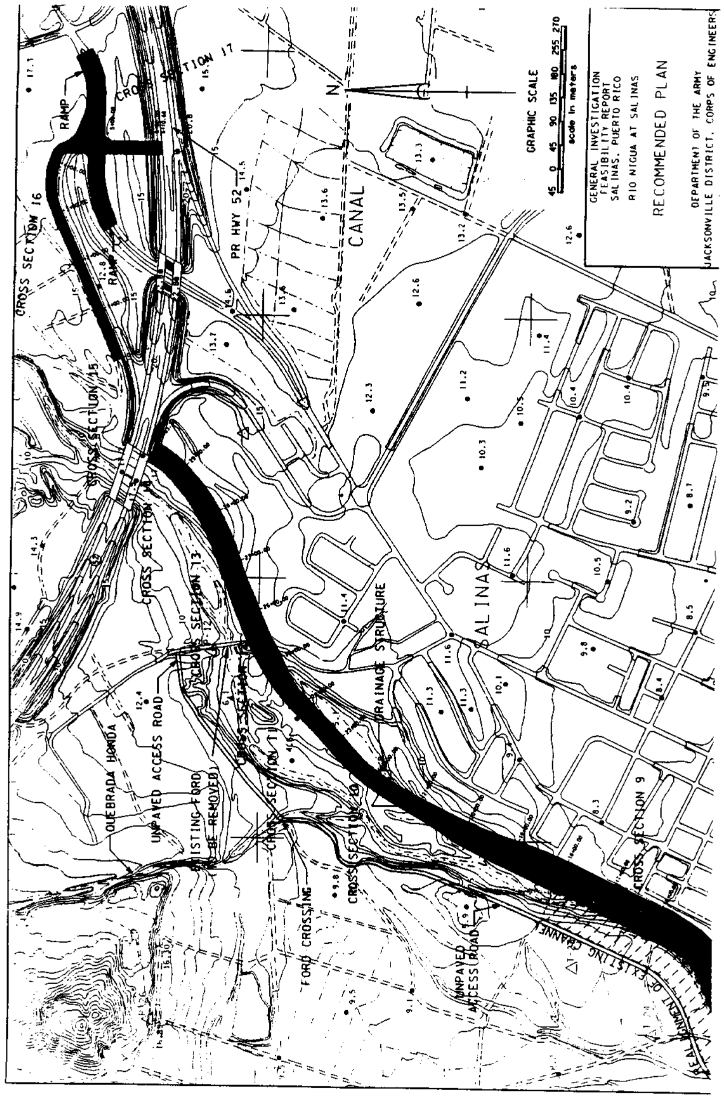
P L A T E S

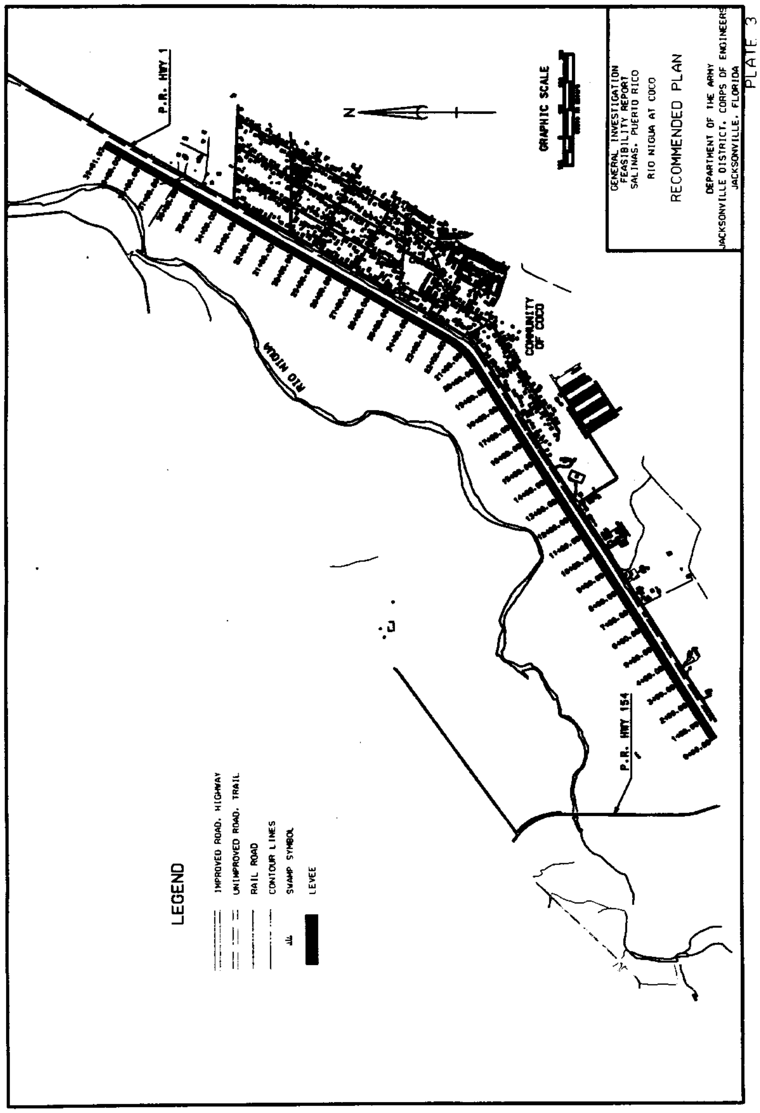




LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
YEAR FLOODED AREA
SPF FLOODED AREA
P.R. HWY 1
P.R. HWY 154
COMMUNITY OF COCO
N
GRAPHIC SCALE
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
EXISTING CONDITIONS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE 1B


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GRAPHIC SCALE
45 0 45 90 135 180 225 270
scale in meters
N
UNPAVED ACCESS ROAD
CROSS SECTION 8
CROSS SECTION 7
CROSS SECTION
DRAINAGE STRUCTURE
HIGHWAY 1 BRIDGE
(TO BE REPLACED)
DRAINAGE STRUCTURE
RAILROAD
CROSS SECTION 4
RAILROAD BRIDGE
(TO BE REMOVED)
REALIGNMENT OF
EXISTING CHANNEL
RIO NIGUA
CROSS SECTION 3
CROSS SECTION 2.5
RAMP
CROSS SECTION 2
LIMITS OF LEVEE
OVERTOPPING REACH
CROSS SECTION 1


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
GRAPHIC SCALE
scale in meters
CANAL
PR HWY 52
SALINAS
DRAINAGE STRUCTURE
QUEBRADA HONDA
UNPAVED ACCESS ROAD
EXISTING FORD TO BE REMOVED
FORD CROSSING
UNPAVED ACCESS ROAD
RAMP
CROSS SECTION 9
CROSS SECTION 10
CROSS SECTION 11
CROSS SECTION 13
CROSS SECTION 15
CROSS SECTION 16
CROSS SECTION 17


P.R. HWY 1
N
GRAPHIC SCALE
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE 3
COMMUNITY OF COCO
RIO NIGUA
P.R. HWY 154
LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
CONTOUR LINES
SWAMP SYMBOL
LEVEE

ENVIRONMENTAL ASSESSMENT

FLOOD CONTROL STUDY

RIO NIGUA AT SALINAS, PUERTO RICO

Jacksonville District
September, 1996

RIO NIGUA AT SALINAS, PUERTO RICO
FLOOD CONTROL STUDY ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

ATTACHMENTS

Environmental Assessment
Flood Control Project

Río Nigua at Salinas, Puerto Rico

1.00 SUMMARY.

This Environmental Assessment was prepared to comply with the National Environmental Policy Act (NEPA) by documenting environmental issues associated with building and operating a flood control project as recommended by a study of flooding at Salinas, Puerto Rico by the U.S. Army Corps of Engineers (Corps). The study was authorized by a resolution adopted by the Committee on Public Works and Transportation, United States House of Representatives, on October 1, 1986. The Department of Natural and Environmental Resources (DNER) is the local sponsor for the project.

The proposed action is construction of a flood control project on the west side of Salinas *municipio* on the south coast of Puerto Rico, consisting of two separate and discontinuous earthen levees along the east bank of the Río Nigua. The levees would provide protection for the rural community of El Coco and the town of Salinas, including Playa de Salinas, against river over bank flooding. The recommended plan levee for Salinas and Playa de Salinas is about 3 kilometers (1.8 miles) long. It would begin behind the coastal dune berm and extend up to, and slightly north of, Highway 52, with a short section extending eastward from the main levee to protect the Highway 1 - Highway 52 intersection. The levee crest elevation would vary between 5 meters (near its north end) to 1.5 meters near the coast. The levee would be revetted on the flood side. Most of this levee would be built over uplands, with exceptions as noted below. The separate levee recommended for Coco community, located about 3.2 km (2 mi.) upstream from Salinas, will be about 4 km (2.5 mi.) long, average 3.7 meters (12 feet) high, and will be protected by grassy side slopes. The Coco levee will be built entirely over uplands. Both earthen levees will have 2.5 horizontal on 1 vertical side slopes and a 3 meter wide crown. Additional features of the Salinas levee are described herein. (1) Two bridges require removal and documentation to Historic American Engineering Records (HAER) standards. They are an old sugarcane railroad bridge and the existing bridge on Highway 1 that crosses the river south of Salinas center. The highway bridge will be replaced by a modern, high chord bridge and ramp structures to provide adequate flood conveyance. An additional cultural resource, part of an historic archeological site, may be impacted by the project, requiring further studies and documentation. (2) Fill materials consisting of levee revetment and one concrete bridge pier may be placed in the river channel over an aggregate of less than one acre. (3) Re-alignment of the existing river channel is proposed, both north of the Highway 1 bridge and north of the railroad bridge, over an aggregate of

less than 1.9 acres, to avoid relocating numerous residential structures. (4) 30 residences and 2 commercial buildings may require removal and relocation of the residents; (5) An unpaved ford across the river, south of Highway 52, will be removed and a substitute access road to the west bank will be provided, beginning at the new Highway 1 bridge to be built. (6) A ramp will be built over the levee in the coast lowlands, south of Salinas, to provide access to coastal properties near the river mouth, east bank, that would otherwise lose access. Because the recommended plan will not significantly change river flow or discharge to the coast or invade the estuary, no adverse secondary effects of plan implementation on coastal natural resources are expected. Expected environmental benefits include improvements in public safety , reduction of flood damages to residences, commerce, public buildings and agricultural crops, increased employment and reduced flood insurance costs.

No significant natural resources would be adversely affected by the project: no threatened or endangered species, coastal barrier resource segments, wetlands areas, or significant fish and wildlife habitat would be adversely affected; and therefore no fish and wildlife mitigation actions are proposed. Resource agencies consulted during coordination of the Draft Report and EA concurred with this determination. An underground tank associated with a gasoline station located near the Highway 1 bridge may be affected, and an estimate for removal and remediation are included in the cost estimate. An estimate for the cost of cultural resources mitigation is also included in the project cost estimate. Cultural resources mitigation, if these properties cannot be avoided, would consist of further studies and documentation, if necessary, for the archeological site, and documentation to Historic American Engineering Record (HAER) standards, for the bridge(s). The State Historic Preservation Officer (SHPO) has concurred with this determination and further requested investigation to determine if significant vernacular structures are located in the project footprint.

After evaluation of the probable positive and adverse effects of the considered project on the human and natural environment of the study area, and considering that complete mitigation measures for any potential adverse effects have been identified, a finding of no significant impact (FONSI) has been written and is included in this report and EA. This Environmental Assessment and the Preliminary Finding associated with it were coordinated with concerned agencies and individuals as shown at Attachment A, beginning on May 7, 1996. A Public Meeting was held in Salinas, Puerto Rico, on May 23, 1996, to provide additional opportunity for interested citizens to inform themselves about study results and the recommended plan No adverse comments, either oral or written, were received.

2.00 PROJECT LOCATION. The Río Niguà study and project area is located on the south coast of Puerto Rico, approximately 33 kilometers (21 miles) east of Ponce. The river arises in the central mountains, entering the upper coastal area through Camp Santiago National Guard Base, to the west side of the rural community of Coco. It crosses under Las Américas Expressway (Highway PR-52) and passes along the west side of the municipality of Salinas, including the Playa de Salinas neighborhood, before reaching the coast. All significant urbanization has occurred on the east bank of Río Nigua.

3.00 **PURPOSE OF AND NEED FOR ACTION.** The purpose of the study was to investigate alternatives and identify a feasible plan to alleviate flooding problems affecting the urban area of Salinas and Playa de Salinas, and in Coco rural community.

High rainfall in the headwaters area, steep upper slopes, lack of dense plant cover in the middle river basin, and high impermeability of the substrate that characterize most of the upper Río Nigua basin promote fast runoff and allow minimal infiltration of the surface water. These factors combine with high intensity and long duration rainfall to produce over bank flooding in the lower part of the basin, particularly in the town of Salinas and surrounding communities. Coco community is a rural satellite of Salinas, located several kilometers upstream, along the east side of Highway 1. Coco is also affected by flooding from river overflow. It is a relatively compact residential area, separated from town by undeveloped, open land.

3.01 Historic Floods. Salinas, including the "Playa" sector, and Coco have been inundated several times by the overflow of Río Nigua. The last major flood in Salinas was the "Three Kings Day" flood of January, 1992. A major flood, reported in the Flood Atlas for the region (Haire, 1971), occurred in October, 1970. This well-documented flood, corresponding to a 10-year recurrence event, was used to calibrate Corps models. For additional discussion of flood probability and stages refer to Main Report Appendix A (Hydrology and Hydraulics).

3.02 Potential Flood Damages. The majority of Salinas' estimated 28,000+ residents live in flood prone areas. About 3,022 families, more than 250 commercial structures, dozens of public buildings, roads, water and sewer lines, power lines and communications utilities are within the 100-year flood zone. Agricultural areas located southeast of the urban center also are flood prone; these areas are gradually converting from sugar cane to "minor fruits" (pineapple, winter crops including peppers, onions and tomatoes).

3.03 Flood Damage. Floodable areas under existing conditions are shown in Main Report Plate 2. Estimates of potential damages associated with different flood frequencies for existing conditions are discussed in Main Report Paragraph V.A.6. Total expected annual damages under existing (without project) conditions are $1,152,000 for the Salinas-Playa area and an additional $1,700,400 for Coco community.

3.04. Goals, Planning Objectives and Constraints. The overall goal was to design a flood control project that would protect lives, minimize financial and personal property damages, minimize economic and social disruption, enhance regional growth opportunities, and avoid adverse effects on significant natural and cultural resources, including species of special concern, wetlands, designated coastal barriers, historic and archeological resources.

4.00 PROPOSED ACTION. The recommended plan involves building two separate earthen levees that would protect Coco community and the town of Salinas, including Playa de Salinas (Salinas Port). Refer to the Main Report plates and Appendix A Plates for details of the proposed works. The levees are described, as required by Corps of Engineers policy, in accordance with the results of risk and uncertainty analysis. Please refer to Appendix 1 of the Main Report (Hydrology and Hydraulics) for an explanation. Levees would be of earthen construction, with 2.5 horizontal to 1 vertical side slopes and a 3 m (10 foot) top width. The Coco levee would extend south-westward inside the Camp Santiago fence, along the western side of the community, west of Highway PR-1, paralleling the highway for about 4 km (2.5 mi.). Levee height would average 3.8 m (12 feet) at the design section, and the levee would provide better than 100-year protection (0.33% probability of overtopping in any year, equivalent to a 300-year flood). This levee would run along the grassed east bank of the river. The recommended levee corresponds to the National Economic Development (NED) plan levee.

The Salinas levee would begin 730 meters upstream of Highway 52 at Highway 1, running along Highway 1 to high ground at the PR-52 overpass, where it would be truncated. A short spur levee would start at the upstream side of the east abutment of the Highway 52 bridge, follow a highway access ramp, and end downstream from the highway's exit ramp to PR Highway 154. This spur levee would be protected on the floodside with gabions. On the south of the overpass the main Salinas levee would extend southward along the east bank of the river to a point below the railroad bridge; southward from this point the low levee would lead nearly due south to a point just north of the coast line, thereby avoiding the Coastal Barrier segment at the river mouth. Levee height would be about 5 m (16.5 ft) at the northern end, decreasing from the Highway 52 overpass to the mouth, where it would be 1.5 m high. Levee height at the cross-section used for sizing (risk and uncertainty), in Salinas town, would be 4.5 m (15 ft) high. The levee would provide at least SPF-level protection (0.01% probability of overtopping). This is the NED plan levee. Other features of the recommended Salinas levee include: (1)minor channel realignments requiring fill of 1.9 acres of eastern-side channel bottom and excavation of an equivalent 1.9 acres of west-side bank, at locations just north of the Highway 1 bridge and near the old railroad bridge; 2)replacement of the Highway #1 bridge on the south side of Salinas, ramping this highway up over the levee to the level of the new high chord bridge; (3) removal of 30 residences and 2 commercial buildings, all in the vicinity of the bridge removal, ramps or channel re-alignment, with relocation of the affected families; (4)removal of an unpaved ford over the Río Nigua located just south of PR-52, substituting access to the buildings and businesses thus isolated via the new Highway 1 bridge and a new, west bank access road to be built; (5) ramping an unpaved agricultural access road over the levee near its southern terminus to provide access to 60 acres of agri-cultural lands that would otherwise be isolated, and(6)provision of interior drainage channels on the protected side of the levee and construction of three flap-gated culvert structures to convey flood drainage from the protected to the flood side of the levee. The recommended plan assumes it will be necessary to remove and document a deteriorated historic agricultural railroad bridge located in the floodway. A radio station and gasoline station located near the Highway 1 bridge over the river may be affected by the project. If the gasoline station is affected, its underground tank may need to be removed, and this removal has been accounted for in the project cost estimate, although avoidance is the preferred alternative.

5.00 **ALTERNATIVES TO THE PROPOSED PLAN.**

5.01 No-action and Non-structural Alternatives. The no-action alternative would allow flooding to continue as at present. Potential flood threat to life, property, and health would continue to limit economic development of the area. Periodic disruption of economic activities and services at the local and regional levels would impair opportunities for further economic development.

Non-structural measures considered included flood and storm surge early warning systems, flood plain management regulations (enforced by the Puerto Rico Planning Board), flood insurance, evacuation and housing relocation. Economically viable non-structural alternatives are assumed to be in operation under all final alternative plans. Flood plain management is implemented by the Puerto Rico Planning Board through its Regulation #13 (regulating new developments in flood-prone areas). This regulation severely restricts subdivision, development and encroachment into the 100-year flood plain, but cannot apply retroactively to development that occurred prior to its adoption. Application of Regulation 13 in Salinas, in the absence of effective structural flood control measures, has severely hampered new residential, commercial and industrial development during recent years, as noted in the Main Report. The undeveloped lands adjacent to the town on the east bank, while uplands, are all within the 100-year flood plain. A flash flood alert system is in place on the upper Nigua watershed, and will complement the proposed project. Voluntary participation in federally-subsidized flood insurance programs has been low due to the relatively high perceived cost of the coverage, but insurance is available in Puerto Rico. Insurance can only compensate for property damage and does not address risks to life and limb. Other non-structural measures considered include stream cleanup and temporary or permanent flood plain evacuation. Stream cleanup (removal of trash, debris and obstructing vegetation) would reduce minor flooding and is a desirable alternative, even in the absence of any other measures, but would not provide significant protection from low recurrence frequency, high stage floods that were the subject of this study. Routine cleaning of flood-prone stream reaches is a function of the Department of Natural and Environmental Resources under Commonwealth funding, and can be presumed to occur under all considered alternatives.

Temporary evacuation of persons and personal property from flood prone areas could be accomplished when a flood threat exists, if sufficient advance warning of flood conditions is available. Temporary evacuation can be very effective when operated in conjunction with a reliable flood forecasting system. Such a system (called "ALERT" for Automated Local Evaluation in Real Time) is in operation on Rio Nigua. It relies on sensors placed in the upper watershed to alert Civil Defense personnel to imminent floods and trigger mobilization and evacuation of affected areas. The ALERT system has been installed on the Río Nigua, which has an extremely steep upper watershed, leading to short duration flood peaks that allow little time for prior evacuation. Temporary evacuation would help to reduce flood risk to life and limb, but lead times are very short, making complete evacuation difficult; moreover, since most of the property subject to flooding is immobile, there still are considerable economic losses. Municipal Civil Defense likewise has a storm surge evacuation plan, to alert residents to coastal flood hazards. In general there is greater "lead time" to evacuate coastal residents as a storm approaches. However, the single road leading from Playa de Salinas back into town will flood from the river if rainy weather begins in the highlands before a coastal surge hits; this creates a dangerous situation requiring early and vigorous measures to evacuate vulnerable coastal areas, starting before over bank flooding becomes imminent.

Permanent flood plain evacuation could be used to reduce flood damage potential. Such a measure would involve land purchase, removal of buildings and improvements, and relocation of the population to alternate, suitable housing. However, the area is densely populated. Permanent evacuation of the flood plain is practicable only when a relatively small number of structures, of low value, are located in the flooded area. In the case of Salinas and El Coco, these conditions were not met: more than 3,000 families and hundreds of businesses and public buildings would be involved. This measure was not considered further due to its extremely high cost.

5.02 Structural Alternatives.

Preliminary structural measures evaluated include flood retention (building an upstream reservoir), flood proofing, channel improvements, floodwalls and levees. No suitable reservoir sites could be found upstream on the Río Niguas; the upper watershed is very steep and narrow.

Flood proofing would require raising a large number of structures that are now inundated, so that they would remain above design flood stages. It was not considered further because it would have been as costly as permanent relocation, and would not have allowed access to businesses or residences during floods.

Channel improvements were considered among the preliminary alternatives evaluated. Channel improvement requires relatively large quantities of excavation and disposal; furthermore, the excavated channel would require costly periodic maintenance. Any channel improvements in the lower part of the river would have required avoidance of the designated Coastal Barrier around the river mouth. Channel improvements were retained only for the cut and fill channel relocation needed near the Highway 1 bridge on the west side of town, where the only available alignment for the east bank levee would encroach on the existing channel. This improvement is really a re-sculpting of the river bed, involving placement of fill on the east bank and complementary excavation along the west bank to provide a cross-section comparable to the river prior to construction.

Floodwalls and levees. Flood walls and levees are measures capable of reducing the flooding problem in the study area. Levees were expected to be efficient and practical because most flooding occurs along the east river bank; nearby quarries were identified, capable of producing sufficient levee material, and levees are a relatively low-cost flood control alternative. Advanced plan formulation optimized the length, height and alignment of the levees to provide greatest net annual benefits in relation to project costs.

6.00 AFFECTED ENVIRONMENT.

This section will provide a description of existing resources in the immediate project area followed by a description of future conditions based on a without project condition that assumes that no action is taken to correct the flooding problem.

6.01 General Environmental Setting. Río Nigua originates in the Cordillera Central (the central east-west trending mountain range that is the watershed divide for Puerto Rico) near the town of Cayey, at an elevation of about 860 meters (2,821 feet). The river flows approximately 29 kilometers (18 miles) toward the southwest, passing west of the town of Salinas, to discharge into the Caribbean Sea. High mountains of volcanic origin are common in the northern and northeastern part of the basin. The topography of the southern portion is characterized by gentle sloping hills and a coastal plain. The coastal plain is separated from the rest of the basin by PR Highway 52 which crosses the flood plain from east to west. There are few diversion structures within the basin. Those that exist are being used for irrigation and water supply, and their storage capacity is very small.

The uppermost part of the watershed is wet, receiving significant amounts of rainfall during all months of the year. In contrast, the south coastal area is in the "rain shadow" of the central range, which intercepts a significant fraction of the moisture present in the prevailing easterly trade winds. The average annual rainfall within the basin varies from 196 centimeters (77 inches) in the headwaters to 112 centimeters (44 inches) in the lower coastal plain. There is a pronounced dry season most years, beginning in January and often lasting through July or early August. Hurricanes and tropical storms can produce very heavy rainfalls late in summer and into the fall. Cold fronts may also create heavy rainfalls during winter and early spring. Around Salinas, at least seven out of twelve months are arid. During the long dry season, water entering the middle reaches of the river is exposed to several miles of unshaded gravel bed, and almost all of the flow percolates into the alluvial fan or evaporates, leaving only a trickle at the level of el Coco and Salinas.

The principal soil types found in the basin are Descalabrado-Rockland complex, Caguabo clay loam, Jácana clay, Guamaní silty clay loam, and cobbly alluvial land. These soil groups produce high runoff with a slow infiltration rate. The cobbly alluvial land and the Guamaní soils occur along streams, rivers, and in the river flood plain. In the steep mountainous headwaters of the river, soils are shallow to bedrock, with little water holding capacity. The upper Nigua watershed is heavily forested; parts are in the Carite Commonwealth Forest. Agriculture predominates in the lowlands and along the flood plain: it includes horse and cattle ranches, irrigated sugar cane farms, and smaller minor fruit crop acreage. Agricultural land use on the lands surrounding Salinas is expected to continue; and some lands are converting to more economically favorable winter vegetable cropping from sugar cane. An irrigation system is in operation to complement the relatively low amount of rainfall that commonly falls in this semiarid region.

Opposite el Coco rural community, the very large Camp Santiago Natural Guard base covers the middle and parts of the upper watershed on the west river bank. Camp Santiago is a major military training base which seasonally hosts a significant influx of guardsmen and other military units visiting from off-island to participate in tropical training exercises. The housing areas of the base are not inside the flood zone. Use of Camp Santiago is expected to continue as at present.

Residential, commercial, industrial and public uses are those most affected by flooding. Service-related employment is more important than agriculture as a source of income in Salinas, with about 39% of the population engaged in government service. This economic activity is affected severely and adversely by over bank flooding. Low-stage flooding occurs frequently, as documented in the Main Report. Expansion of the town center of Salinas and development or diversification of the economic sector have been constrained by Planning Regulations now in place, since all of the undeveloped floodplain lands adjacent to the population centers is in the 100-year floodplain, subjecting them to the constraints of Planning Regulation 13. (Any development must be raised above the 100-year flood level and may not significantly worsen flooding in the remaining floodway). This situation will continue as at present in the absence of flood control measures. Flooding can also cause considerable damage to crops under existing conditions. Sugar cane, the traditional crop in this area, is not greatly damaged by short-duration flooding, except during the harvest period; however, such crops as pineapple, plantains, bananas, and "winter" vegetables can be lost to early (June-July) or late (October-December) wet season flooding.

6.02 Biological Resources. The Río Nigua is typical of south coast rivers: it generally experiences low to intermittent flow during the long dry season. High water flows are usually associated with short duration flash flood events. Original (climax) vegetation on the central-south coast was a semi-deciduous forest dominated by *Bucida buceras* (ucar) and other drought tolerant hardwoods (Ewel and Whitmore 1973). Most of the lands surrounding the middle and lower river have been converted to grassland (pasture) or irrigated row-crop agriculture (sugarcane). A large part of the middle watershed is occupied by Camp Santiago, which has been almost completely deforested by past unchecked wildfires and now is covered by a sparse grassland. The Commonwealth of Puerto Rico's Natural Heritage program reports no significant wildlife or fish species from the lower lands of Camp Santiago. Private lands above and to the east of Camp Santiago appear heavily overgrazed. At the lower end of the flood plain the river estuary is short, consisting of sparse mangroves developed over the river mouth delta gravel. The river's intermittent flow regime limits the size of the trees and the spread of the mangrove forest and tidal wetlands at the mouth of the river, since salt levels build up in the soils during each dry season. The river mouth delta is a designated Coastal Barrier (PR-47), and it provides the only significant wetlands and wetland-associated bird habitat in the study area. Upstream of the river mouth parallel to the coast on both river banks is a beach ridge which is covered with a dense mesquite (*Prosopis juliflora*) woodland. Upstream of the mesquite scrub the natural low flow channel widens, forming dense stands of giant sedge (*Cyperus giganteus*) and cattails (*Typha domingensis*) in the low wet areas where water is either ponded or the soils stay saturated for long periods of time. On both sides of the low flow channel the bank abruptly rises 5-10 feet to a terrace that supports scattered individual upland trees and grasses. Common species include West Indian elm(*Guazuma ulmifolia*), silk-cotton(*Ceiba pentandra*), the "guamá" (*Pithecellobium dulcis*), acacias (*A. tortuosa, A. farnesiana*) saman(*Pithecellobium saman*) and others. This channel form -- a wet low flow bottom with bordering higher dry terraces -- extends upstream through the rest of the project area.

Wildlife in the study area is limited by the sparse plant cover, human disturbance and limited feeding and nesting areas. Upland birds are the most conspicuous faunal element. Common species include greater Antillean grackle, smooth-billed ani, zenaida, white-winged and mourning doves, ground dove, gray kingbird, mockingbird, pearly-eyed thrasher, bananaquit, and Adelaide's warbler. Common lizards include the "siguana" (*Ameiva exsul*), grass and tree anoles (*Anolis pulchellus, Anolis cristatellus*). The commonest amphibians are the south American toad (*Bufo marinus*) and the white-lipped frog (*Leptodactylus albilabris*). No significant wildlife elements are associated with the uplands above the channel and terraces--either in the private, agricultural lands surrounding Salinas, Playa and Coco communities or inside lower Camp Santiago. There are likewise no significant wildlife elements located in any of the potential excavated material disposal sites. These areas are presently grazed and (infrequently) subjected to fires during the dry season; their lack of dense shrub and tree cover and use for grazing severely limit their habitat value.

6.03 Threatened or Endangered Species. The U.S. Fish and Wildlife Service (USFWS) by letter dated April 8, 1993 identified the Antillean Manatee (*Trichechus manatus*, E), Yellow-shouldered blackbird (*Agelaius xanthomus*, E), Hawksbill sea turtle (*Eretmochelys imbricata*, E), and the Brown pelican (*Pelecanus occidentalis*, E) as the only species which might potentially occur within the project area. Subsequent coordination as the study and plans developed eliminated Service concerns with these species, all of which are coastal. The Final Coordination Act Report submitted in August 1995 (Attachment EA-D) documented that none of the named species are present in the project's footprint or likely to be adversely affected.

6.04 Cultural, Historical, and Archeological Resources. Archival research and cultural resource field investigations were conducted for the area of proposed impact for the Río Nigua flood control study. The results of these investigations are included in the report *Cultural Resources Survey of the Río Nigua Flood Control Study, Municipio of Salinas, Puerto Rico* (Cinquino 1995), which was submitted to the Jacksonville District by Panamerican Consultants. Field investigations identified a total of 21 cultural sites. The archeologist recommended that eight of these resources may be significant and eligible for inclusion in the National Register of Historic Places. Identified resources include: the concrete bridge on Highway 1, constructed 1939; 1905 railroad bridge; railroad water tank; segments of a historic irrigation system; a historic archeological site; and three prehistoric archeological sites. The irrigation system and three prehistoric sites were all located in a disposal area which had been proposed for the project. An alternate disposal site was identified and was subjected to field investigations conducted by Jacksonville District archeologist, David McCullough. No cultural materials were identified in the disposal area located south of Highway 52 and west of the town of Salinas.

6.05 Water Quality. The general quality of surface waters of the island, especially in the coastal fringe, is poor. Coliform standards violations occur frequently; they are probably due to a large rural population lacking adequate waste disposal facilities, inefficient treatment and disinfection of waste waters at treatment plants, and an increased land area dedicated to dairy farms and pasture. Surface waters from this river are not used for potable water supply in the coastal river segment, because of the intermittent nature of the supply.

Development of rivers for direct contact recreation, especially near the coast, is not possible because contamination presents a public hazard due of the risk of diseases. Drinking water for Salinas comes from a series of wells operated and maintained by the Puerto Rico Aqueduct and Sewer Authority (PRASA).

6.06 Hazardous Toxic and Radiological Wastes (HTRW). A preliminary assessment was conducted in May 1993 to address the existence or potential for occurrence of contamination on lands, including structures and submerged lands, in the Río Nigua at Salinas project/study area. The preliminary assessment included a project review, site literature/document review, and site reconnaissance. During each assessment, the following signs of potential HTRW problems were looked for:

Landfills, dumps or disposal areas; burning or burned areas; tanks (underground or surface); vats, lagoons, ponds or basins; sludge pits; excavations (pits, quarries, borrow areas); wells; containers of unidentified substances; spills, seepage or slicks; odors; dead or stressed vegetation (brown, spotted, curled or withered leaves); water treatment plants; ditches, trenches, or depressions; mounds and dirt piles; transport areas (i.e., boat yards, harbors, rail yards, airports, truck terminals); and abandoned buildings.

The Río Nigua project site was audited on 26 May 1993 with negative results. After the project final footprint was developed, the site was re-visited in late 1995. The proposed borrow/disposal sites were also checked at this time, with negative results. At this second visit it was noted that a gasoline station located near the existing Highway 1 bridge over the river might require removal to accommodate the Salinas levee, new bridge or road ramps. There is an underground storage tank associated with this station, but it is not known if it is a source of contamination. Its presence has been noted and a contingency estimate for its removal and associated remediation, should this prove necessary, has been made.

6.07 Aesthetic Resources. Consideration of aesthetic resources within the project study area is required by the National Environmental Policy Act of 1969 (NEPA), as amended, and ER 1105-2-100. Aesthetic resources are defined as "those natural and cultural features of the environment that elicit a pleasurable response" in the observer, most notably from the predominantly visual sense. Consequently, "aesthetic resources are commonly referred to as visual resources,...features which can potentially be seen." Existing viewsheds within the study area encompass the central mountain range to the north, the Caribbean sea to the south (visible from most of El Coco), trees and shrubs along the river channel, and grassy pastures along most of the undeveloped west bank. At the rural Coco community, Camp Santiago's rolling grasslands are dramatically backed by the abrupt saw-toothed ridge of La Cordillera-the central mountains. El Coco is a typical rural roadside community, only a few streets across, made up of single-story wood and block residences, and surrounded by open countryside.

South of the Hwy. 52 bridge, Salinas is a densely-packed traditional community, with most multi-story buildings concentrated around a central Plaza and facing inward, located several blocks away from the river. The channel east bank is lined with smaller, single story concrete residences. The opposite bank is mostly open pasture. Toward the south side of town, just north of the Highway 1 bridge crossing, a small outlying community comprising a few wooden or wood and concrete block single-story residences encroaches on the west channel bank. Behind this community, on the opposite side of a secondary road, is a traditional fenced cemetery. Farther south, the river channel continues toward the southwest, away from residential developments. The coastal "playa" neighborhood has no view of the river. Under existing conditions no significant changes in the visual resources of the study area are expected.

6.08 Recreation. Authority to consider Federal development of project-related recreation resources is contained in Section 103 (c)(4) of the 1986 Water Resource Development Act. Basic legislation is further affected by the Land and Water Conservation Fund Act (Public Law 88-578), the Federal Water Project Recreation Act (Public Law 89-72), and the Water Resources Development Act of 1986 (Public Law 99-662). The Corps' objective in terms of recreational development is to "fully consider the recreation potential that may be applied at Corps Civil Works Projects"(ER 1165-2-400). Based on information provided by the Puerto Rico Statewide Comprehensive Outdoor Recreation Plan (SCORP), the following recreation facilities can be found in the Salinas Municipality: 15 Baseball & Softball Fields; 16 Basketball Courts; 4 Passive Parks; 3 Cockfight Rings; 6 Recreation Centers; 1 athletic field; 1 swimming beach; 4 recreation facilities; 1 golf course. The existing recreation facilities have a high use rate and are forecasted to increase in the future.

6.09 Noise. Ambient noise levels in the project area are low to moderate. The major noise producing sources are vehicular traffic within the residential areas along the river and through traffic along the Las Américas Expressway (Highway PR-52) and Highway 1. However, this main road is mainly lined with public and commercial buildings as it leads west out of Salinas center and crosses the river. These sources are expected to continue at their present noise levels. Noise in the future will increase, if the threat of flooding is eliminated, as residential and commercial development increases in affected communities.

6.10 Air Quality. Air quality in the Río Nigua area is good due to the influence of steady on- or offshore coastal breezes. As in most coastal areas of Puerto Rico a sea breeze-land breeze system develops over most of the year. There are no major emitters in the Salinas airshed; the nearest contaminant sources are a refinery and a government owned electric power generating plant, both located in Guayama, about 8 kilometers and 12 kilometers distant upwind from town.

The Puerto Rico Environmental Quality Board, Air Quality Division classifies the Río Nigua project area as an attainment area. No appreciable decrease in air quality is expected in the future.

6.11 Socioeconomic Conditions. The Municipality of Salinas covers an area of 179 square kilometers (69 square miles). Flooding and high unemployment rates have inhibited the urban expansion and economic development of the town.

The principal urban areas within the Río Nigua flood plain are the town of Salinas and the communities of Sabana Llana, Coco, and Playa. Portions of Camp Santiago, a military installation used for training by the Puerto Rico National Guard and U.S. Navy communications facilities, also are within this flood plain. The "pueblo" or town sector is the main urban center of the Municipality, a relatively small dense area located along the margins of the Río Nigua. About half of the total population lives within the flood plain. Many commercial buildings and the public hospitals are within the floodable area. The Municipality is connected to the island's primary highway system through PR Highways 1, 3, and 52. There are several second and third order highways and municipal roads linking all the "barrios" and rural communities with each other and with the neighboring municipalities.

The most important income and employment generating activities in the study area are government, agriculture and manufacturing, with commerce, commercial fishing, and services accounting for the remainder. About 39 per cent of employment is in the government sector, and an additional 22 per cent is in agriculture. Unemployment is relatively high and is likely to remain so. Many of the residents of areas immediately adjacent to the river and most flood-prone enjoy a relatively low income.

6.12 Coastal Barrier Resources. The mouth of the Río Nigua encompasses Coastal Barrier Resource System unit PR-47, as designated by Congress in the Coastal Barrier Improvement Act of 1990. The unit extends approximately 0.65 kilometers (2,100 feet) on both sides of the river mouth along the coast. At the river mouth the unit extends approximately 0.4 kilometers (1,400 feet) inland, to include the wetlands areas described in Paragraph 6.02.

7.00 ENVIRONMENTAL EFFECTS.

7.01 General Environmental Effects. The proposed flood control plan would build two discontinuous levees along the eastern bank of Río Nigua, with associated construction borrow, disposal, earth movement, bridge removal and replacement at Highway 1, gabion protection of the flood side at Salinas, installation of drainage structures (culverts), replacement of road accesses and minor realignment of the main channel near the Highway 1 river crossing to account for encroachment on the east river bed by the existing and proposed flood control levee. Since the recommended plan does not include measures to divert, retain or detain river flows, few significant effects on the natural environment of Salinas and Coco community will occur as a result of plan implementation. As discussed in the main report and in detail below, the following minor effects have been identified and will be addressed: An estimated 30 residential structures will be removed; there will be some temporary increase in general background noise adjacent to Coco and Salinas town, as earth moving activities related to levee construction occur; Due to the arid climate and large amounts of material to be moved, a potential will exist for construction machinery to generate fugitive dust; however, all applicable management practices to avoid dust emission, such as protection of loads, wetting down of temporary haul roads, and others, will be incorporated into project specifications. The Corps' contractor would be monitored for compliance with specifications and air quality regulations.

Removal and relocation of residences has been minimized. The east bank of the river, in Salinas itself, is lined with family residences. A low "levee" of concrete, built as part of a local flood reduction project some years ago, extends up to the rear entrances of many of these residences. This concrete apron is not high enough to offer any real flood protection benefits. In this area the river channel will be slightly re-aligned toward the west, to avoid the need to remove an entire line of the east bank residences and in so doing, disrupt a long-established neighborhood. Unfortunately, a smaller number of residences on the west bank will need to be removed to accommodate the re-alignment of the channel.

Noise control measures include construction only during normal daylight hours (probably, 7-3:30 or 7:30-4), monitoring the contractor to assure proper noise control devices (mufflers, etc.) are operating on all earth-moving equipment; and routing dump trucks, etc. on roads outside of the town center. The project will be constructed in compliance with local maximum noise levels and is not expected to generate nuisance noise levels nor interfere with normal activities.

Traffic congestion could be a problem during replacement activities for the bridge on Highway 1 over the river. However, the all-season (elevated) nearby Highway 52 offers a ready alternative for by-passing the congested area. Care will be taken to coordinate closely with the Puerto Rico Highways Authority to assure that maximum advantage is taken of the dry season (when the river is little more than a trickle and easily crossed with temporary fords) and that route detours are carefully planned and executed to avoid unnecessary congestion at Salinas center.

7.02 Biological Resources. General construction activities will cause only temporary adverse effects on wildlife and fish resources in the river channel. The proposed upland borrow and disposal areas were examined by Corps and FWS biologists. They do not support significant wildlife elements. Lands will be restored to gentle contours after borrow/disposal activities and will be re-grassed (that is, existing dominant vegetation will be replaced). Lands used for borrow/disposal are expected to revert to prior use (pasture or military training). The levee elements of the recommended project would be built on uplands except for a short stretch (about 0.7 ha or 1.9 acres) of the Salinas town levee (just north of the Highway 1 bridge and near the railroad bridge). In this area, a short section of the west bank will be excavated (graded down) to provide conveyance to replace the existing river bed, where the east bank would be filled by the levee. The "cut and fill" quantity is estimated to be about 96,000 cubic m (125,000 cubic yd) of material. The aquatic bed wetlands affected are nearly devoid of vegetation, due to the existence of an old concrete floodwall along this channel section. Shrub and emergent wetlands (probably dominated by *Cleome* and umbrella sedge) are expected to develop on the fringe of the realigned channel. Fish and shrimp species that inhabit or migrate through the channel will be disturbed for the duration of construction; typically these species are displaced up- or downstream and can avoid the small area where the east levee will encroach on the river bed. Neither FWS nor the Corps considered this a significant effect, and no mitigation is planned. In essence, a non-vegetated (concrete) channel bank will be replaced by emergent vegetation. The preliminary alignment would also have buried a small area of coastal wetlands, but this impact was avoided by levee redesign during formulation of final plans. Levee floodside revetment and replacement of a concrete bridge pier will also result in minor deposits of materials inside the waters of the river, but the area to be covered is less than one acre, in the aggregate, and the materials are inert in nature, and not expected to cause any adverse effects. Most of the levee revetment will be installed on levees traversing uplands (above the "normal" or low-flow water line). After a preliminary alignment was developed, Corps staff inspected the entire flood control study area with staff of the U.S. Fish and Wildlife Service, Boquerón Field office. A small area of coastal salt-flat wetlands was identified adjacent to the recommended project levee alignment. Siting the levee over these wetlands, considered significant wildlife habitat by FWS, would have required compensatory mitigation. As a result of further hydraulic analyses and optimization of levee heights and widths, the coastal levee was realigned to avoid these wetlands completely. The Fish and Wildlife Coordination Act Report (Attachment EA-D) documents resolution of wetlands concerns.

7.03 Threatened or Endangered Species. Federally protected species known to inhabit the general area are marine, dependent on mangroves, or coastal-nesting. No protected species have been identified in the project footprint, and neither primary nor secondary adverse effects are expected. No Commonwealth species of special concern were identified in the project area. The Coco levee will run through sparse grassland, and the Salinas levee will run alongside the urbanized east bank of the river, ending north of the coast. FWS has stated that it does not expect the recommended structures to affect listed species.

7.04 Cultural, Historical, and Archeological Resources. As discussed in section 6.04 of this environmental document, eight significant historic resources were identified during cultural resource investigations for this study. Identified resources include: the concrete bridge on Highway 1, constructed 1939; 1905 railroad bridge; railroad water tank; segments of a historic irrigation system; a historic archeological site; and three prehistoric archeological sites. An alternate disposal area was selected, allowing the project to avoid impacting the historic irrigation system and the three prehistoric archeological sites. The railroad water tank appears to be outside of the proposed area of impact and can also be avoided. The historic railroad bridge may still be removed by the Commonwealth of Puerto Rico prior to project construction, but is assumed to be in the project footprint and subject to mitigation by documentation.

Historic properties which may be affected by the Federal project, as currently proposed, include the Highway 1 bridge, the railroad bridge and a historic archeological site. The project's affects on these resources will be adverse and will require mitigation. Proposed mitigation for loss of the bridge(s) includes documentation to Historic American Engineering Record (HAER) standards. Additional fieldwork will be conducted for the archeological site and a data recovery plan will be developed, if determined necessary. The draft cultural resource report and proposed mitigation were coordinated with the Puerto Rico State Historic Preservation Officer. In a letter dated January 11, 1995, SHPO concurred with the District's determinations of effect and proposed mitigation. SHPO also concurred with the draft EA, in a letter dated May 28, 1996. SHPO has requested that the District determine if the flood control project will affect significant vernacular structures. If such structures are significant and will be adversely affected by project construction, the SHPO has requested documentation of those structures. The Corps concurs with this recommendation, but does not anticipate that the project will affect significant vernacular structures.

7.05 Water Quality. Short term increases in water turbidity are expected due to construction activities. All appropriate management measures to reduce water turbidity during construction will be adopted and incorporated into project specifications. It is believed that conditions would return to normal soon after construction activities have terminated.

7.06 Hazardous, Toxic and Radiological Wastes. The preliminary survey and the follow-up conducted in late 1995 did not identify any area of HTRW contamination. The underground tank associated with the gasoline station is not a known source of ground contamination, but it will be removed if it falls within the project footprint. The project cost estimate includes an estimate of the cost of tank removal and remediation, if required.

7.07 Aesthetic Resources. The Coco levee will be located across Highway 1 from the community, far enough removed from residences that it should not adversely affect views to the coast or the mountains. Residences adjacent to the east river bank inside Salinas town will have views to the west (over pasturelands) partially blocked. The protected side of the levee will be grassed to blend into the rest of the viewshed. A short distance below the Highway 1 bridge the levee departs from residential areas, and will not affect visual aesthetics.

7.08 Recreation. An analysis of existing recreation facilities and opportunities on the project led to proposal of development of a designated walking/bicycling trail along the top of the Salinas levee, on the segment extending from south of Highway 52 to the beach. A cost estimate was developed for this proposal and a Recreation Resource report was prepared. However, no cost-sharing partner for this proposal has been identified, and no project-specific recreation is now proposed.

7.09 Noise. There will be a temporary increase in ambient noise during project construction, due to the operation of heavy earth moving machinery. This machinery will operate only during normal daytime hours. The Coco levee will be built inside the Camp Santiago National Guard base, at least 200 feet from the nearest residences and schools. The Salinas-Playa levee will be built along the river bank, and in some segments construction noise may be a temporary nuisance to adjacent residences; however, no violations of the Puerto Rico Environmental Quality Board's Noise regulation will occur as a result of construction.

7.10 Air Quality. Due to the long dry season, fugitive dust can be generated by excavation and deposit of fill material. The Puerto Rico Environmental Quality Board, through its Air Quality Control Regulation, specifies measures that must be incorporated to prevent emissions of fugitive dust, including covering dump trucks with tarpaulins or other covers to prevent flying dust, and watering down transport vehicles and unpaved roads. The Air Quality Regulation will be strictly complied with and contractors will be required to obtain all necessary permits prior to beginning work if the project is approved.

7.11 Socioeconomic Effects. The recommended plan requires removal of 30 residential and two commercial buildings. Residences are all located on the west bank floodway of the river, north of the existing Highway 1 bridge. Commercial buildings include a gasoline station and the offices of a radio station. Every attempt was made to minimize relocation of residences during project design, but leaving these residences in place would have required greater excavation on the east side of the river, where an unbroken wall of residences abuts the old concrete "floodwall". A larger number of residences would have required removal on the east side, leading to even greater community disruption. Construction of the project will will prevent damages to residential, commercial, public and industrial properties due to flooding, which occurs almost annually, as well as protecting the main coastal evacuation route from the "playa" sector in times of hurricane or coastal flood warnings. Incidental protection of 132 acres of vacant flood plain upland adjacent to town is expected to provide economic development benefits, as this land is presently restricted from development by the Commonwealth under Planning Board Regulation 13. Likewise, protection of croplands near the southeastern corner of the Salinas town center is expected to reduce economic losses due to crop flooding. Perhaps the most important social benefit to residents is the freedom from fear and worry related to life-threatening flash flooding, which has regularly claimed lives in the area, most recently when two drownings occurred in Coco community during the Three Kings Day floods of 1992.

7.12 Coastal Barrier Resources. Coastal Barrier PR-47 will be avoided under the recommended plan. No project features would be sited inside the barrier. The mangrove and salt marsh wetlands of the barrier will not be affected by changes in timing or delivery of flood waters, in comparison to current conditions, because the project provides levee protection from, rather than channeling or diversion of, flood waters.

7.13 Unavoidable Impacts and Irretrievable Commitments of Resources. The following unavoidable impacts have been identified: about 1.9 acres of very sparsely vegetated river bottom would be covered by the Salinas levee as discussed in Paragraph 7.02, although an equal area of river bed will be created on the west bank; the historic Highway 1 Bridge and the historic railway bridge would have to be documented and removed, to assure adequate flood conveyance in the lower Río Nigua at Salinas channel, although the railroad bridge may be to be removed prior to project construction by the Commonwealth; an historic archeological site may also be destroyed and would be documented, as detailed in paragraph 7.04. No significant adverse impacts to wetlands, the coastal barrier segment, wildlife, fisheries or endangered or threatened species are expected. The proposed project will not decrease or change the timing of freshwater flows to the estuarine wetlands at the mouth of the river.

Construction of the levees will induce slightly higher flood stages along one flood-prone segment of the river, south of Highway PR-52. As discussed in the Real Estate Appendix to the main report, no additional damages are attributed to this unavoidable effect, because (1) there are no residences in this area; (2) there are no crops planted in the area; (3) adjacent flood-free lands are available for grazing animals; and (4) flooding is estimated to be of sufficiently short duration that is will not cause lasting damage to pasturelands.

7.14 Indirect and Cumulative Impacts. There are no other known flood control or major infrastructure development projects under construction or planned for the Río Nigua at Salinas coastal plan. Therefore, this project does not have the potential to cause additional adverse impacts on the environment. Because residential construction around the developed core of Salinas has been severely constrained (Planning Board Regulation No. 13 does not allow subdivision of floodable lands) under existing conditions, it is possible that provision of a flood protection project will eventually induce new residential development, especially along the southern and eastern margins of the now-developed area, in what are now croplands. This is not a planned purpose of the project, but it may occur at some unknown future time. The current and planned future use of these lands, according to available documents, is agricultural. In fact, the Agriculture Department, which owns many of the parcels, can be expected to act to retain most of them in agriculture, which has recently shifted from low-yield sugarcane farming to more economically beneficial fruit and vegetable crops. In the final analysis the Puerto Rico Planning Board and local zoning and permitting authorities, in consultation with the Department of Agriculture, will decide the "best" use of these lands.

7.15 Relationship between Short Term Use of the Environment and Maintenance of Long Term Productivity. The Río Nigua at Salinas Flood Control Study led to formulation of a plan for long-term control of high-stage, infrequent floods in the coastal plain, allowing for orderly economic development of the region. The recommended plan is designed for a useful life of 50 years, and does not require significant trade-offs of long-term benefits for short-term development. Most of the lands outside of the town center are agricultural, and are likely to remain so, including nearly all of the west bank of the river. Because the hydrology of the river will remain as at present (no damming, retention or diversion of river waters is contemplated in the recommended plan), and because the plan minimizes adverse effects on natural and cultural resources, including historic and archeological resources, wildlife, fisheries and wetlands, no losses in long-term productivity are expected.

8.00 ENVIRONMENTAL COMMITMENTS.

Required permits for this project will be obtained prior to construction. A Puerto Rico Planning Board concurrence with the Corps' Coastal Zone Consistency Determination will be required in order to finalize project coordination in accordance with the Coastal Zone Management Act (see following Chapter, Paragraph 9.07). Concurrence has now been applied for from the Planning Board (PRPB), in accordance with PRPB's requirement for pre-coordination of the EA prior to considering the CZM consistency application. A Water Quality Certificate will be required from EQB for the discharge of fill material in the river bed, and it will be requested after coordination of this Environmental Assessment is concluded, for similar reasons. A National Pollutant Discharge Elimination System (NPDES) Permit or waiver will be required from the Environmental Protection Agency (EPA). Additional "minor permits" will be obtained by the Corps contractor prior to construction start-up, since they depend on submission of Plans and Specifications.

Mitigation will be required for the adverse effects of the project on identified cultural resources, including: the historic Highway 1 bridge, the historic railway bridge, and the historic archeological site identified in the 1994 survey. The bridges will be documented to HAER standards; mitigation for the historic archeological site would consist of further study and documentation. Structures to be removed (a few residences on the west bank near Highway 1) will be surveyed to determine and document the existence of significant vernacular architecture.

After close coordination with the Puerto Rico Department of Natural Resources and FWS, and as documented in the Fish and Wildlife Coordination Act Report (CAR), no significant adverse impacts to fish and wildlife resources or wetlands are expected as a consequence of project construction, and no mitigation is now proposed.

9.00 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS.

9.01 National Environmental Policy Act of 1969, as amended. Environmental information on the project has been compiled and the Environmental Assessment was coordinated with concerned agencies and publics during May-July, 1996 prior to finalization in accordance with the National Environmental Policy Act. A list of EA recipients appears on the first page of the Coordination Attachment (Att. EA-A) Comments received are duplicated. Only the EQB comments required a response. This comment, a translation and the Corps response are shown in the above named Attachment.

9.02 Endangered Species Act of 1973, as amended. A list of endangered, threatened, proposed, or candidate species was received from the U.S. Fish and Wildlife Service dated March 1993. Informal consultation was initiated by the Corps in April, 1993 and concluded in January 1995.

Although several species were listed as potentially present in the general area, joint field surveys with the Service led to the conclusion that species of concern do not occupy the project footprint in January, 1995. This conclusion was confirmed in the draft Coordination Act Report (dCAR), dated March, 1995, followed by a revised CAR in August, 1995. This project was fully coordinated under the Endangered Species Act; therefore, it is in full compliance with the Act.

9.03 Fish and Wildlife Coordination Act of 1958, as amended. In response to the requirements of this Act, the Corps has begun and will continue to maintain continuous coordination with the USFWS during all stages of the planning and construction process. In August 1995 the USFWS submitted a final Fish and Wildlife Coordination Act Report (CAR), which is included in this report as Attachment EA-D.

9.04 National Historic Preservation Act of 1966, as amended. Cultural resource investigation, documentation, and coordination with the State Historic Preservation Officer is in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, 36 CFR Part 800, and the Archeological and Historic Preservation Act. Further studies and mitigation for cultural resources identified in the project footprint have been discussed at Paragraph 7.04. By letter dated May 28, 1996, the SHPO concurred with the findings of this EA.

9.05 Clean Water Act of 1972, as amended. The study is in partial compliance. Full compliance will be achieved with issuance of a Water Quality Certificate from the Commonwealth EQB and an NPDES permit or waiver from US EPA. Receipt of the Water Quality Certificate is expected in mid-1997. EQB will accept an application once the NEPA coordination of this EA is completed; this also will satisfy Commonwealth environmental review regulations. Certification is expected. A Section 404(b)(1) Evaluation is included in this report as Attachment EA-B. The Environmental Protection Agency (EPA) concurred with the Environmental Assessment and Preliminary Determination of No Significant Impact in a letter dated July 11, 1996.

9.06 Clean Air Act of 1972, as amended. Coordination on May 10, 1993 with the Puerto Rico Environmental Quality Board, Air Quality Division determined the proposed project was in partial compliance with the Clean Air Act. There are no non-attainment areas inside the study area. After receipt of comments and concurrence with the EA from EQB and EPA, the project is now in full compliance.

9.07 Coastal Zone Management Act of 1972, as amended. The study is in partial compliance at this time. Full compliance will be achieved with receipt of concurrence with the Corps' Determination of Consistency from the Puerto Rico Planning Board. A federal consistency determination in accordance with 15 CFR 930 Subpart C and PRPB rules was mailed on

September 4, 1996. Concurrence is expected within 30 days. The Determination and application for concurrence is attached at EA-C.

9.08 Farmland Protection Policy Act of 1981. No prime or unique farmland will be impacted by implementation of this project. Corps evaluation of soil maps of the study and immediate project area, as compared to current prime and unique farmland soils lists for Puerto Rico, showed that soils under the levee and channel re-alignment footprint belong to groups that are not classed as prime or unique farmlands in Puerto Rico. The Natural Resource Conservation Service did not respond to circulation of the EA during the public comment period. Although non-response could be interpreted as concurrence, subsequently, a letter detailing the study and EA's conclusions was mailed to NRCS in San Juan, requesting a statement of concurrence with our findings. Concurrence of NRCS is expected within 30 days.

9.09 Wild and Scenic River Act of 1968, as amended. No designated Wild and Scenic river reaches will be affected by project related activities. This act is not applicable.

9.10 Estuary Protection Act of 1968. No estuary recognized under this Act will be affected by project activities. All flood control structures (Salinas levee) will avoid the river estuary.
The project will not affect freshwater flows or timing at the estuary. The project is in compliance.

9.11 Federal Water Project Recreation Act, As Amended. The principles of the Federal Water Project Recreation Act, (Public Law 89-72) as amended, have been fulfilled by complying with the recreation cost sharing criteria as outlined in Section 2 (a), paragraph (2).

9.12 Resource Conservation and Recovery Act of 1976, Public Law 94-580; 7 U.S.C. 100, et seq. If the gasoline station cannot be avoided in the vicinity of the Highway 1 bridge, the underground tank would have to be removed in accordance with this law and its regulations. This item would be Commonwealth responsibility; a cost estimate has been included in the project cost.

9.13 Toxic Substances Control Act of 1976, Public Law 94-469; U.S.C 2601, et seq. This law has been determined to be not applicable as there are no items regulated under this act either being disposed of or affected by this project.

9.14 E.O. 11990, Protection of Wetlands. This Act requires that Federal Agencies avoid impacts to wetlands unless there are no practicable alternatives. It further requires that Federal Agencies minimize losses to the beneficial values of wetlands and preserve and enhance the beneficial values of wetlands. The U.S. Army Corps of Engineers' wetland mitigation goal is one of no net loss of wetlands. During early plan formulation a plan that would have impacted coastal salt marsh wetlands was under consideration. Upon receipt of the Draft Coordination Act Report and after reevaluating the hydraulics of the lower flood plain, a plan was identified that permitted project structures (the lower levee) to completely avoid these wetlands. The recommended plan is in compliance with this Executive Order.

9.15 E.O. 11988, Floodplain Management. This Act requires that Federal agencies comply with the following four conditions: (a) avoid development in the floodplain unless it is the only practicable alternative; (b) reduce the hazard and risk associated with floods; (c) minimize the impact of floods on human safety, health and welfare; (d) restore and preserve the natural and beneficial values of the floodplain. Other than the "no action" alternative, there is no practicable alternative to development in the base floodplain with a river flood control project. As described in the Alternatives Section 6.00, the "no action" alternative was determined not to be an acceptable solution. The selected alignment minimizes impacts to the floodplain.

9.16 E.O. 12898, Social Justice. This executive order states that minority and low income populations must not be disproportionately affected by substantial adverse project effects. The Rio Nigua at Salinas project is in compliance. Much of the study area would be characterized as "low-income" by Federal standards. As stated in the report, unemployment is high in Salinas and housing options are limited due to the flood-prone nature of many neighborhoods. Many of the most flood-prone communities that will be protected under the flood protection project recommended by this report and EA are low-income communities. Such communities include parts of El Coco, parts of Salinas playa, and many of the east-bank residences in the urban core of Salinas. A few residences must inevitably be removed to provide space for levees, minor channel re-alignment and other project features. However, the project was designed specifically to minimize relocations of families and the social disruption that accompanies it, and it does not specifically target a particular ethnic or economic group for protection, or, conversely, relocation.

9.17. Coastal Barrier Improvement Act of 1990. A segment of undeveloped coastal dune encompassing both banks of the mouth of Río Nigua at Salinas comprises Puerto Rico Coastal Barrier Reserve segment PR-47. This Act prohibits federal expenditures that foster development in designated barrier segments. The recommended plan does not contemplate any structural measures or other activities inside the barrier segment, and would not cause adverse effects on the wetlands or other natural resources of the segment; therefore it is in full compliance with the purposes of the Act.

10.00 COORDINATION. The study was coordinated with the Following agencies: U.S. Fish and Wildlife Service, Puerto Rico State Historic

Preservation Officer (SHPO), Puerto Rico Environmental Quality Board Air Quality Area, Puerto Rico Department of Natural and Environmental Resources (the co-sponsor), Puerto Rico Planning Board and other major Puerto Rico infrastructure agencies, beginning early in the feasibility stage of the planning process (see also Attachment EA-A). Scoping was initiated by letter dated March 4, 1993 to potentially interested parties. The Draft Feasibility and EA were circulated for public comment, beginning on May 7, 1996 (for Commonwealth agencies). The Federal comment period began on June 10 and ended on July 25. An informal public meeting was held on May 23, 1996 in the Salinas sports coliseum to present the study's conclusions, the recommended plan, and to elicit public comments and questions, in Spanish. No written comments were received from this meeting. Written comments on the Draft Report/EA are attached at EA-A, and consisted entirely of letters of support, endorsements, concurrences and "no-objection" findings.

11.00. LIST OF PREPARERS. This EA was prepared by:

Barbara Cintron, Biologist and main writer, USACE
Janice E. Adams, Archeologist, USACE
David McCullough, Senior Archeologist, USACE
Paul Stevenson, Landscape Architect, USACE
Ivan Acosta, Environmental Engineer, USACE
Roberto Cortés, Civil Engineer, USACE
This EA was reviewed by:
Elmar Kurzbach, Chief, Environmental Studies Section, USACE
Hanley Smith, Chief, Environmental Branch, USACE

12.00 REFERENCES.

Cinquino, Michael A. 1995. Cultural Resources Survey of the Río Nigua Flood Control Study, Municipio of Salinas, Puerto Rico. Manuscript submitted to the U.S. Army Corps of Engineers, Jacksonville District by Panamerican Consultants, Inc.

Puerto Rico Department of Natural Resources, Puerto Rico Planning Board, and U.S. Department of Commerce, NOAA. 1978. Puerto Rico Coastal Management Program and Final Environmental Impact Statement. San Juan, P.R. DNR. 194 p., maps.

Ewel, J.J. and J.L. Whitmore. 1973. Ecological Life Zones of Puerto Rico and the United States Virgin Islands. USDA Forest Service, Res. Paper ITF-18. Institute of Tropical Forestry, Rio Piedras, PR. 72 pp.

Haire, W.J. 1971. Floods in the Salinas Area of Puerto Rico. U.S. Geological Survey. Atlas HA-447.

EA ATTACHMENT A

PUBLIC COORDINATION AND AGENCY CORRESPONDENCE

RECIPIENTS OF THIS ENVIRONMENTAL ASSESSMENT

Federal Agencies

U.S. Environmental Protection Agency (USEPA), Region II, New York and San Juan.
U.S. Fish and Wildlife Service, Caribbean Field Office, Boquerón, P.R
U.S. Dept Commerce, National Marine Fisheries Service, SE Region
U.S. Department of Agriculture, Nat. Res. Conserv. Service, San Juan.
Commander (OAN) Seventh Coast Guard District, Miami.
U.S. Geological Survey, Caribbean Field Office, San Juan, P.R.
Director, Federal Emergency Management Agency, San Juan Office

Commonwealth of Puerto Rico Agencies and Offices

Hon. Pedro Rosselló, Governor.
Hon. Basilio Baerga, Mayor, City of Salinas.
Hon. Carlos Romero Barceló, Resident Commissioner.
Hon. Roberto Rexach, President, Puerto Rico Senate.
Hon. Zaida Hernández, President, Puerto Rico Chamber of Representatives.
Ms. Norma Burgos, Chairperson, P.R. Planning Board (Copy, Director, Land Use Bureau).
Mr. Hector Russe, esq., President, P.R. Environmental Quality Board (5 copies).
Mr. Pedro Gelabert, Secretary, P.R. Department of Natural and Environmental Resources (5 copies).
Ms. Lilliane López, P.R. State Historic Preservation Officer Director, Centro de Investigaciones, Institute of Puerto Rican Culture.
Secretary, Puerto Rico Department of Agriculture
Executive Director, Puerto Rico Electric Power Authority.
Executive Director, Puerto Rico Aqueduct and Sewer Authority
Secretary, Puerto Rico Department of Transportation and Public Works.
Executive Director, Puerto Rico Highways Authority.
Executive Director, Puerto Rico Telephone Company.
Director, Puerto Rico Civil Defense.
Superintendant, Puerto Rico Police Department.

Public Interest and Conservation groups

Puerto Rico Conservation Trust, San Juan, P.R.
Puerto Rico Conservation Foundation, Hato Rey, P.R.
Puerto Rico Engineers and Surveyors' Assocation, San Juan, P.R.

Letters of concurrence received as of 8-15-96. No objections were raised. The Environmental Quality Board made a series of recommendations. This letter appears in Spanish, followed by a translation to English, with Corps response to each point on the page opposite. The U.S. Department of the Interior, Fish and Wildlife Service, sent no comments. It had concurred with the findings of the study in the Coordination Act Report (reproduced following this Attachment as Attachment D).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

JUL 1 1 1996

A. J. Salem, Chief
Planning Division
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

The Environmental Protection Agency (EPA) has reviewed the draft feasibility report and Environmental Assessment (EA) for the flood control project for the Rio Nigua in the vicinity of the town of Salinas, Puerto Rico.

The EA evaluated several structural and nonstructural alternatives, as well as the no-action alternative, to address planning objectives. The preferred alternative involves construction of two earthen levees along the east bank of the Rio Nigua, as well as revetment of the levee slopes and removal of a deteriorated agricultural railroad bridge. Under the preferred alternative, 1.9 acres of non-vegetated river channel would be filled to prevent destruction of houses when building the levee; the aquatic ecosystem associated with this loss would be replaced by widening the other side of the river. The preferred alternative is the least damaging in terms of aquatic resource impacts.

Based on our review, we do not anticipate that implementation of the preferred alternative will result in significant adverse impacts to the environment. Accordingly, EPA has no objections to its implementation.

If you have any questions concerning this letter, please contact Deborah Freeman of my staff at (212) 637-3814.

Sincerely yours,

Robert W. Hargrove, Chief
Environmental Impacts Branch

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

June 7, 1996

Colonel Terry Rice
District Engineer, Jacksonville District
Department of the Army, Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Rice:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Feasibility Report and Environmental Assessment (EA) for the Rio Nigua at Salinas flood control study dated May 29, 1996. The project is located on the east bank of the Rio Nigua and would run intermittently to the coast at Salinas, Puerto Rico.

The NMFS believes that the preferred alternative has been designed to avoid the significant marine and estuarine wetland resources within the project area. Our concerns and comments from previous correspondence have been addressed and incorporated into the document. We, therefore, concur with the EA's Finding of No Significant Impact.

If you have any questions regarding these comments, please contact Mr. John Iliff of our Miami Field Office at 305/595-8352.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Director
Habitat Conservation Division

OFFICE OF THE GOVERNOR
LA FORTALEZA

Control 96-1879

May 28, 1996

Mr. Roberto Cortés Colón
Chief, Antilles Planning Section
Department of the Army, Antilles Office,
400 Fernández Juncos Avenue
San Juan, PR 00901-3299

SHPO #08-23-89-06 NIGUA RIVER FLOOD CONTROL PROJECT, SALINAS, PUERTO RICO

Dear Mr. Cortés:

We received and reviewed the Draft Feasibility Report and Environmental Assessment (February 1996) for the Río Nigua at Salinas flood control study. We concur with the information presented in this report regarding cultural resources.

If you have any other questions, please do not hesitate to contact our Office.

Sincerely,

por Lilliane D. López, Arch.
State Historic Preservation Officer

LDL/ MB/ OT

STATE HISTORIC PRESERVATION OFFICE

100

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES

DNER

August 19, 1996

Col. Terry Rice
District Engineer
U.S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Rice:

The Puerto Rico Department of Natural and Environmental Resources has reviewed the draft Feasibility Report and Environmental Assessment for providing flood control at Rio Nigua, Salinas, Puerto Rico, and concurs with the findings and recommendations contained therein. We actively participated in the public meeting held on May 23, 1996 in Salinas to discuss the findings of the study and obtain comments from the general public and all concerned entities.

This letter of intent, while not considered a binding contract, is furnished to document our support of the recommended plan of improvements and our intent to act as local sponsor for its implementation.

The Department of Natural and Environmental Resources is legally capable of fulfilling all the requirements of the Project Cooperation Agreement in accordance with Section 221 of the Flood Control Act of 1970. Project funding will be obtained by annual appropriations from the Puerto Rico Legislature for the capital investment program for flood control works managed by this Department.

Sincerely,

Pedro A. Gelabert
Secretary

JAA/RAM/JGL/als

[illegible], San Juan, P.R. / Box [illegible], Pta. de Tierra Station, P.R. [illegible] / Tel. (809) [illegible]

ESTADO LIBRE ASOCIADO DE PUERTO RICO / OFICINA DEL GOBERNADOR
JUNTA DE CALIDAD AMBIENTAL

ASESORAMIENTO CIENTIFICO

30 de julio de 1996

DADA-7099-96

Sr. Mr. A. J. Salem
Chief Planning Division
Department of The Army
Jacksonville District Corps of Engineers
Antille Office
Ave. Fernandez Juncos 400
San Juan, Puerto Rico 00901-3299

Asunto: EA 96-0035 (ARMY)
Control de Inundaciones
Río Nigua/Comunidad Coco
y Playa de Salinas
Salinas, Puerto Rico

Estimado señor Salem:

La Junta de Calidad Ambiental ha analizado el documento ambiental sometido para el proyecto de referencia.

Entendemos que al presentar el mismo su instrumentalidad cumplido con la fase de evaluar el posible impacto ambiental la acción propuesta, de acuerdo con el Artículo 4 (c) de la Ley sobre Política Pública Ambiental, Ley Número 9 del 18 de junio de 1970, según enmendada. No obstante, para una mejor realización de la acción propuesta, esta Junta emite las siguientes recomendaciones:

1. Durante la fase de construcción del proyecto, se deberá cumplir con las disposiciones del Reglamento para el Control de la Contaminación por Ruido, en lo relacionado al nivel de sonido máximo permitido. Se deberá tomar las medidas de control de ruido necesarias durante la fase de construcción del proyecto para garantizar la tranquilidad y el bienestar general de las áreas adyacentes. Las obras de construcción deben realizarse durante el período diurno.

2. Previo a dar comienzo a la construcción o efectuar algún movimiento de tierra, deben obtener de esta Junta los siguientes permisos:

   a. Permiso Fuente de Emisión (PFE) para polvo fugitivo durante la etapa de construcción.

Sr. Mr. A. J. Salem
EA 96-0035 (ARMY)
Página 2
30 de julio de 1996

   b. Para realizar una Actividad Generante de Desperdicios Sólidos (Formulario DS-3).

   c- Plan para el Control de la Erosión y Sedimentación de los Terrenos (CEST).

3. Durante la construcción es importante proveer medidas para controlar las emisiones de polvo fugitivo, de acuerdo con las Reglas 404 y 108 del Reglamento para el Control de la Contaminación Atmosférica (RCCA), vigente. Estas medidas deberán tomarse en cuenta durante las tareas que envuelven remoción de la capa vegetal, movimiento y nivelación de terreno y el movimiento vehicular por áreas de acceso y rodaje.

4. Durante la fase de construcción deberán tomarse las medidas necesarias para evitar que residuos de solventes, grasas, aceites, u otras sustancias químicas, puedan ser arrastradas por la escorrentía y, ganen acceso a un cuerpo de agua o sistema pluvial.

5. De tener alguna descarga de contaminantes (incluyendo aguas sanitarias, aguas de proceso y otros efluentes a cualquier cuerpo de agua) deberán solicitar y obtener un Permiso Federal de Descarga "NPDES" de la Agencia Federal para la Protección Ambiental (AFPA). Además, deberá obtener un Certificado de Calidad de Agua de esta agencia.

6. Coordinar las alternativas para las áreas de disposición de material dragado y áreas de material de préstamo, con el Departamento de Recursos Naturales y el Servicio Federal de Pesca y Vida Silvestre (USFWS, por sus siglas en inglés).

7. Realizar los trámites pertinentes con la Autoridad de Energía Eléctrica y la Compañía Telefónica de Puerto Rico en relación a la construcción propuesta y las líneas que podrían ser impactadas durante el referido desarrollo.

Sr. Mr. A. J. Salem
EA 96-0035 (ARMY)
Página 3
30 de julio de 1996

8. En caso del establecimiento, reemplazo o cierre de algún tanque, se deberá consultar con el Programa para el Control de Tanques de Almacenamiento Soterrados (PCTAS) para determinar si dicho (s) tanque (s) está (n) cubierto (s) por el RCTAS. Si dicho (s) tanque (s) está (n) cubierto (s) por el RCTAS, deberán:

   a. Cumplimentar una notificación federal de tanques soterrados ("Underground Storage Tank Notification").

   b. Solicitar y obtener del PCTAS la correspondiente autorización para la instalación de dicho (s) tanque (s).

   c. Solicitar y obtener el correspondientes certificado de cumplimiento de dicho (s) tanque (s) a tenor con el RCTAS.

9. Deberá confirmar que el servicio de recogido que van a utilizar para el acarreo de los desperdicios sólidos generados en el área de proyecto tenga la debida autorización del Area de Control de Contaminación de Terreno.

10. Deberán tramitar el correspondiente permiso del Cuerpo de Ingenieros del Departamento del Ejército de los Estados Unidos, conforme a la Ley de Ríos y Puertos de 1899 y la Sección 404 de la Ley Federal de Agua Limpia ("Clean Water Act").

11. Se deberá solicitar una consulta de compatibilidad de parte del Programa de Manejo de la Zona Costanera, adscrito al Departamento de Recursos Naturales y Ambientales (DRNA).

12. De determinarse que el terreno esta impregnado con combustible (durante la remoción del tanque de gasolina), se deberá cumplir con los requisitos de muestreo y análisis de acuerdo con la reglamentación vigente.

13. Se deberá realizar las correspondientes consultas a las agencias concernientes, respecto a los recursos culturales e históricos y cumplir con los requisitos de dichas agencias al respecto.

Sr. Mr. A. J. Salem
EA 96-0035 (ARMY)
Página 4
30 de julio de 1996

Agradecemos su cooperación por mantener y conservar la calidad de nuestro ambiente.

Cordialmente,

Héctor Russe Martínez
Presidente

Translation of Puerto Rico Environmental Quality board letter:

DADA-7099-96

Subject: EA 96-0035 (ARMY)
Flood Control
Rio Nigua/Coco Community
and Salinas Playa
Salinas, Puerto Rico

Dear Mr. Salem:

The Environmental Quality Board has reviewed the environmental document submitted for the referenced project.

We understand that, by submitting the document, your agency has complied with the requirements of Article 4 (c) of the Puerto Rico Environmental Policy Law, Law No. 9 of June 18, 1970, as amended. To assure that the proposed project is developed in continued compliance, this Board issues the following recommendations:

1. During the project construction phase you must comply with the provisions of the Noise Control Regulation that set the maximum allowable sound levels. You must incorporate noise control provisions during construction to guarantee the tranquility and well-being of adjacent residential areas. Construction activities should be limited to daytime hours.

2. Before beginning construction or any earth movement, you should obtain the following permits from this Board:

a. Emission Source permit for the fugitive dust during the construction phase;

b. Permit to operate a Solid Waste Generating Activity;

c. Plan/permit for Control of Erosion and Sedimentation of Lands (C.E.S.T. permit).

3. During construction you must provide measures to control the generation of fugitive dust, according to Rules 404 and 108 of the Air Quality Regulation. Measures should be implemented during vegetation clearing, movement and grading of lands and vehicular movement throughout the project, including areas of access and transport.

4. During construction you must avoid release of solvents, grease, oils or other chemical substances into the

Corps of Engineers responses to EQB letter:

Thank you for your acceptance of the EA.

Below, we have provided responses to individual points raised in the EQB's letter. Most of the permits referred to are pre-construction permits obtained by our contractor immediately prior to construction. All construction activity will occur in strict compliance with Federal law and Regulations.

1. (Noise). All construction will occur during daytime hours. We do not anticipate violating the 75 dB limit at any point in construction, as noted in EA Paragraph 7.09.

2. (Incidental permits). These permits will be obtained by our contractor.

3. (Fugitive dust). Measures to control fugitive dust will be incorporated into project specifications. We concur that this is an important consideration, given the arid condition of the river bed during most of the year.

4. (Oil, grease and solvent control). We concur. We will incorporate measures to control and avoid spillage of these materials into project specifications. Such measures are routinely a part of our project "Environmental Protection specifications."

environment where they could be carried by runoff into adjacent water bodies.

5. If the project will generate any pollutant discharges (including sanitary wastes, process waters or other effluents to any water body), you must apply for and obtain an NPDES permit from EPA. In addition you must obtain a Water Quality Certificate from this agency.

6. (You must) coordinate the location of borrow and disposal areas with the Department of Natural Resources and the Fish and Wildlife Service.

7. (You must) coordinate with the Electric Power Authority and the Telephone Company so that they are aware of the proposed construction and lines that might be affected

8. In the case of establishment, replacement or closure of any (underground) tank, you must consult with the Underground Tank Control Program (PCTAS) to determine if it is covered under the PCTAS. If it is, you must:

a) Complete a Federal Underground Storage Tank Notification.

b) Apply for an obtain from the PCTAS an authorization for the installation of said tank;

c) Apply for and obtain a compliance certificate for the tank from the PCTAS.

9. You must confirm that the trash pickup service you intend to use to collect solid waste from the construction site has the required authorization from the Land Pollution Control Area.

10. You should obtain the required permit from the Corps of Engineers under the Rivers and Harbors Act and/or Section 404 of the Clean Water Act.

11. You must obtain consistency certification for the Puerto Rico Coastal Management Program.

12. If you find that the lands are contaminated with fuel during the gasoline tank removal operation, you must comply with requirements for sampling and analysis according to regulations.

5. (NPDES Permit; WQC). As stated in the EA on p. EA-19-20, it is our intention to apply for a permit or waiver from EPA, due to the large acreage that will be subjected to vegetation clearing. This application is normally submitted prior to construction, when plans and construction specifications are available. We will apply for a Water Quality Certificate soon.

6. (Coordination of borrow/disposal with DNER and FWS). As stated in the EA, DNER is a co-sponsor of this project and has been intimately involved in plan formulation and discussion of all project features. FWS was also directly involved from an early stage of plan formulation, under the Fish and Wildlife Coordination Act. Both agencies are aware of the proposed location of all project features, and have concurred. DNER will share the cost of building the project and, as sponsor, will be required to provide all lands required for the project, including borrow and disposal areas. The FWS Coordination Act Report was reproduced as EA Attachment D.

7. (Coordination with infrastructure agencies). We concur fully. Coordination has already begun with PRASA, PREPA, TELCO, cable companies and the Highways Authority.

8. (Underground tanks). The Corps will comply fully with applicable Federal laws, if it proves necessary to remove the tank. At this time it appears that the referenced tank may not fall under the final project footprint, and/or may not be a contaminant source but a contingency amount has been provided for sampling, removal and remediation in the overall project cost estimate.

9. (Trash pickup). Concur. Normally this matter is incorporated into project specifications.

10. (Corps permits). The referenced project is a direct public works construction project of the U.S. Army Corps of Engineers. In lieu of "issuing itself a permit" the Corps normally includes a Section 404(b)(1) evaluation in the EA for the project. This evaluation is at EA Attachment B. The Environmental Protection Agency, in a letter dated July 11, 1996, concurred with the conclusions of the EA and the Section 404 (b)(1) evaluation.

11. (CZM Certification). We are in the process of applying for a consistency certification from the Puerto Rico Planning Board. DNER has already endorsed the project.

12. (Sampling and analysis during tank removal). As stated in reply to (8) above, all such activities would be carried out in strict compliance with applicable Federal law and regulations.

GOBIERNO DE PUERTO RICO
COMPAÑIA DE FOMENTO INDUSTRIAL DE PUERTO RICO

June 14, 1996

Department of the Army
Jacksonville District Corps
of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Attention: Mr. A.J. Salem
Chief, Planning Division
Environmental Branch

Dear Mr. Salem:

Re: Draft Feasibility Report and
Environmental Assessment for
the Río Nigua of
Salinas, Puerto Rico

Reference is made to your notice of May 7, 1996, requesting our comments on the flood protection project report mentioned above.

The Puerto Rico Industrial Development Company endorses the project. We consider that the submitted draft covers the most important details.

Thanks for the opportunity given to our agency regarding this important project.

Cordially,

Alfredo Pérez Zapata
Director, Planning Office

Apartado Postal 362350, San Juan, Puerto Rico 00936-2350

GOBIERNO DE PUERTO RICO
[illegible]
P.O. Box 10163
Santurce, Puerto Rico 00908-1163

28 de mayo de 1996

A.J. Salem
Chief, Planning Division
Environmental Branch
Department of the ARMY
P.O. Box 4970
Jacksonville, Florida 32232 - 0019

Estimado señor Salem:

Re: Caso Núm. 96-69-055-ARMY
Río Nigua, Salinas
A.J. Salem

Acusamos recibo de su comunicación del 7 de mayo del año en curso, donde solicita nuestros comentarios en relación al asunto de epígrafe.

En la consulta de referencia se propone desarrollar un proyecto de control de inundaciones en la parte este del Municipio de Salinas. Este proyecto consiste en la construcción de dos diques. Los mismos proveerán protección a la Comunidad Rural El Coco y el Pueblo de Salinas, del desbordamiento del Río Nigual.

Del documento de Declaración de Impacto Ambiental, se desprende que este proyecto no pretende cambiar la dirección, flujo o descarga del río en la costa, ni se afectarán terrenos de alto potencial agrícola. Entendemos que esta consulta es de gran interés social, ya que mejora la calidad de vida de los residentes de las áreas afectadas por las inundaciones.

A tenor con lo antes expuesto, este Departamento expresa no tener objeción al proyecto propuesto.

Cordialmente,

Miguel A. Muñoz
Subsecretario de Agricultura

BE/edg

13. You must coordinate with the required agencies on cultural resources, and follow their requirements.

Thank you for your cooperation in maintaining and conserving the quality of our environment.

/s/

Hector Russe Martinez
President.

13 *(Cultural Resources)*. Coordination with *SHPO (the lead agency for Federal projects) has been completed. The SHPO recieved a copy of the cultural resources survey results. A letter of concurrence with the report's conclusions was issued by the SHPO on May 25, 1996.*

GOBIERNO DE PUERTO RICO
Autoridad de Tierras de Puerto Rico
Santurce, Puerto Rico 00908

APARTADO 9745 FAX 723-8300

June 10, 1996

Mr. A.J. Salem
Department of the Army
Jacksonville District Corps
of Engineers
PO BOX 4970
Jacksonville, Florida 32232-0019

ATT: Planning Division

Dear Mr. Salem:

We have examined the Draft Feasibility Report and Environmental Assessment (EA) for the Rio Nigua at Salinas flood control study, dated February 1996, and we do not have any comments or suggestions to make, because our properties are sufficiently apart from the project.

However, thak you for the interest to maintain us informed about and if we can be of any assistance in the future development of this project, please let us know.

Sincerely,

Antonio Vélez Ramos por Rafael Brilla Robles
Antonio Vélez Ramos
Executive Director

JARA/mrs

Government of Puerto Rico
Autoridad de acueductos y alcantarillados
Puerto Rico aqueduct & sewer authority

June 6, 1996

Mr. A.J. Salem, Chief
Planning Division
Jacksonville District
Environmental Resources Branch
Department of the Army
Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

Re: **SALINAS, PUERTO RICO**
Draft Feasibility Report and
Environmental Assessment
RIO NIGUA

In response to your letter dated May 7, 1996, our Office has revised the documents submitted and has the following comments:

1. There are in existence various water and sewer pipelines that may be affected by the proposed project.

2. The relocation of pipelines shall be coordinated with this Authority during the design phase of the project in order to avoid damage to the existing facilities.

We appreciate your interest in consulting us.

Cordially yours,

Bertis Ruiz Sotomayor, Chief
Environmental Evaluation Office

VIVIENDA

June 20, 1996

Mr. A. J. Salem
Chief
Planning Division
Jacksonville District Corps of Engineers
PO Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Salem:

The Department of Housing has studied and discussed the Rio Nigua's improvement plan which intent to provide flood protection for the town of Salinas, specifically to the sectors known as *Playa de Salinas* and the Coco Community.

On that area the Department has established fourteen (14) communities that encompass 4,983 families that had suffered in one way or the other, the consequences provoked by floods. For that reason, we have special interest on this plan.

Since all significant aspects had been considered, including engineering, feasibility, economical, social and environmental effects, we agree with State and Federal Agencies to patronize the flood control project. Its implementation will help provide a healthier community life among low income families.

Cordially,

Luz Idalia Estrella Juarbe
Assistant Secretary for
Planning and Technical Services

606 BARBOSA AVENUE · P.O. BOX 21365 · RIO PIEDRAS, PUERTO RICO 00928

108

PUERTO RICO ELECTRIC POWER AUTHORITY
San Juan, Puerto Rico

July 31, 1996

Mr. A. J. Salem
Chief, Planning Division
Environmental Branch
Department of the Army
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

RE: Draft Feasibility Report and Environmental Assessment Rio Nigua at Salinas, Puerto Rico

We have no issues of environmental significance to comment about this project. However, we require that any issue related to electric power lines, be coordinated with our Engineering Distribution Superintendent, Eng. Rafael Meléndez at (787) 289-3062.

Also, it will be necessary to coordinate with Eng. Julio Torres, Irrigation System Supervisor, any issue affecting the irrigation system of the area, at (787) 864-4959. If you have any questions on this matter, please contact Eng. Francisco E. López at (787) 289-4960.

Cordially,

Angel L. Rivera Santana
Director, Planning and
Environmental Protection

US Army Corps of Engineers

NEWS RELEASE
COMUNICADO DE PRENSA

400 Fernandez Juncos; San Juan, Puerto Rico 00901
Phone: 723-0133 Release date:

INVITATION TO COMMUNITY MEETING

ON

SALINAS FLOOD CONTROL PROJECT

The U.S. Army Corps of Engineers will hold a Community Meeting to inform residents of Salinas and Comunidad Coco about the reccomendations of the recently completed Rio Nigua Flood Control Study. Corps of Engineers officials will make the presentation accompanied by Department of Natural and Environmental Resources officials. They will also be available to answer questions from the public.

The meeting will be held next THURSDAY 23 MAY 1996 at 7:00 P.M. at the Coliseo Angel Luis "Cholo" Espada on Hwy.#1,Salinas.

September 5, 1996

Planning Division
Environmental Branch

Mr. Juan Martínez
Director, San Juan Office
Natural Resources Conservation Service
Post Office Box 364868
San Juan, Puerto Rico 00936

Dear Mr. Martínez:

The U.S. Army Corps of Engineers, Jacksonville District, recently coordinated a Draft Feasibility Study Report and Environmental Assessment for a proposed flood control project along the Rio Nigua at Salinas and Coco Community, Puerto Rico. Our records show that your agency received a copy of the subject document, but we have no record of any commentary. We had determined that the project as proposed would not affect prime or unique farmland soils as our study of the Soil Survey publication for this region appeared to indicate no such soils were present. This letter is to document the project footprint and request your concurrence with our determination.

After an unsuccessful search for a prime farmland soils map of the subject area, we evaluated the project's potential to affect designated prime and unique farmlands soils, basing our evaluation on the publication "Soil Survey of the Humacao Area of Eastern Puerto Rico" (USDA, SCS, 1977), and a 1994 list of Prime Farmland Soils of the Caribbean Area. This method was suggested by Carmen Santiago, Natural Resources Conservation Service, San Juan Office. We identified the following soil series in the project levee's footprints:

a. El Coco levee: Guamaní Silty Clay loam (Gm). (inside Campamento Santiago; not irrigated; neither prime nor statewide important).

b. Borrow area: Rock land soils (Rs) and Guamaní silty clay loam (Gm). No prime farmlands.

c. Salinas and Playa levee: Cobbly alluvial land (Cn, river bed and banks), Guamaní silty clay loam (not irrigated); also small areas of Arenales sandy loam, gravelly substratum (Ar), and Vayas silty clay, frequently flooded (Vc), not drained. Not prime farmland.

These latter soils occur in one small area along the east river bank near the former Hacienda Margarita. The lands have been allowed to revert to brush and there are no functional irrigation or drainage works on them. Although the small area of Vc soils is listed as of "statewide importance" we have assumed that this applies only to soils where drainage has been supplied.

To summarize: we have not identified any prime farmland soils under the project footprint. There is one small inclusion of "statewide importance" soils near the southern end of the levee, but the soils no longer have functioning drainage works. We believe we have satisfied the substantive requirements of the Farmland Protection Policy Act by avoiding areas of active and productive agriculture in our levee siting process. We would appreciate a letter indicating your agency's concurrence with the above determinations.

Sincerely

George M. Strain
Acting Chief, Planning Division

Cintrón/CESAJ-PD-ES/1692/mw
Kurzbach/CESAJ-PD-ES
Smith/CESAJ-PD-E
González/CESAJ-PD-PB
Strain/CESAJ-PD

ATTACHMENT B

RIO NIGUA AT SALINAS

CLEAN WATER ACT SECTION 404 (B) (1)

EVALUATION

June 7, 1996

Planning Division
Environmental Branch

Mr. Robert Hargrove
Chief, Environmental Impacts Branch
Environmental Protection Agency
Room 1108
26 Federal Plaza
New York, New York 10278-0001

Dear Mr. Hargrove:

The U.S. Army Corps of Engineers (Corps), Jacksonville District, has completed the feasibility study for flood control along the Río Nigua at Coco Ward and Salinas-Playa de Salinas, in southern Puerto Rico. Enclosed are three copies of the draft Feasibility Report and Environmental Assessment (EA) for your evaluation and comments. The EA follows the main report text and is printed on green paper. Copies of the bound report/EA have been provided to concerned Commonwealth and Federal agencies and individuals during the month of May 1996.

Attachment B of the EA contains the evaluation of proposed discharge of materials (fill) and other activities in Waters of the United States, in compliance with Section 404 (b) (1) of the Clean Water Act. Under the recommended alternative, only 1.9 acres of the river bed would be affected by discharge of excavated material (fill), while an equivalent 1.9 acre area of upland (river bank) would be excavated on the opposite side of the stream. The site of this proposed work is shown on Main Report Plate 2A between brackets as "Realignment of Existing channel." It is in the freshwater stretch of the river. Other incidental discharges of material may occur, to include: replacement of one pier of the Highway 1 bridge (emplacement of pre-stressed concrete piles or pre-cast concrete structural members); and potential small areas of gabion or rip-rap armoring at stream curves (mostly above normal water levels, but possibly impinging on the river bed). The stream is intermittent in the area of work: flow stops or is reduced to a trickle during the dry season. Most earth-moving activity would proceed without affecting water quality, providing near-stream work occurs during the dry season, as planned. Furthermore, there is little wetlands vegetation along the river channel due to its steep banks and intermittent flow. The Corps has judged that these minor additional discharges will not, in the aggregate, affect a significant area of river bed; therefore, we have not explicitly included a discussion of their impacts. However, should further development of the project cause significant changes in the quantity or type of proposed discharge or in the acreages of river bed affected, we would re-open the 404 (b)(1) evaluation process. Due to the large amount of earth-moving required to build the levees over uplands, we have also made a preliminary determination that an NPDES Permit or waiver will be required and we will seek such a permit at the appropriate time.

The U.S. Fish and Wildlife Coordination Act Report (Attachment D to the EA) documents project compliance. During early study and alternatives formulation for Río Nigua at Salinas, Corps staff worked closely with U.S. Fish and Wildlife Service (USFWS) field scientists to develop a flood control alternative package that protected coastal wetlands and the river estuary by avoiding them, thereby reducing or eliminating the need for compensatory mitigation. The preferred alternative discussed in the Feasibility Report and EA will not affect any of the wetlands identified by USFWS, except the minor effects on the river bed discussed in the 404(b) analysis. USFWS has, therefore, concurred with the proposed project.

A draft Finding of No Significant Impact is included in the EA package. In order to be considered, your comments should be received at the above address within 30 days of the date of this letter.

Sincerely,

A. J. Salem
Chief, Planning Division

Enclosure

ATTACHMENT B

CLEAN WATER ACT SECTION 404(b)(1) EVALUATION
RÍO NIGUA AT SALINAS ENVIRONMENTAL ASSESSMENT

I. Project Description

A. Location. Río Nigua at Salinas is located on the south coast of Puerto Rico about 33 km (21 mi) east of Ponce. River headwaters lie on the south drainage of the Cordillera Central in Cayey. The coastal segment of the river floods residential areas in Salinas town, Salinas port and Coco rural community.

B. General Description. The recommended plan comprises two long earthen levees along the east river bank, with bridge removal, minor road relocations and ramping, and a small area of channel realignment, where an existing concrete floodwall and two old bridges the Highway 1 bridge and the old sugarcane railway bridge do not provide sufficient in-bank conveyance. Most of the proposed flood control works (most borrow, levee construction and revetment, and disposal of excess materials would occur on uplands). The upstream (Coco) levee would be about 4 km (2.5 mi) long, and would follow the east bank of the river along Highway 1. It would be about 3.8 m (12 ft) above ground level, with 2.5 horizontal on 1 vertical side slopes, a 3 m (10ft) wide crown, and it would be grassed on both flood and protected sides to prevent erosion. This levee would tie into higher ground at both ends. The Salinas levee would extend about 3 km (1.8 mi), beginning at high ground north of Highway 52 (Las Américas Expressway), truncating at the bridge where this highway crosses the river, and beginning again on the south side, extending through town on the east bank and (partially) in the river bed, and continuing south of town to high ground at the coastal dune berm. This levee would have a short easterly spur, following a road ramp just north of the expressway-Highway 1 intersection, to prevent flood waters from passing under the bridge-overpass at the intersection. Its elevation above ground level would vary, from about 5 m (16.5 ft) north of PR-52, to an average 4.5 m (15 feet) adjacent to Salinas center, to a low of 1.5 m (5 ft) near the coast. The Salinas levee's profile would be identical to that of the Coco levee. One segment of this levee covering an aggregate of 1.9 acres, would be built by depositing clean fill on the east side of the river bed, along about 300 m (aggregate length) involving an estimated 125,000 cubic yd of fill. This fill would be obtained by mechanical excavation from the opposite bank. The result would be a minor realignment of the channel, with the same conveyance as at present. Associated with these two short segments (in the vicinity of the bridge replacement and railroad bridge removal) would be lesser deposits of concrete (one bridge pile, to be replaced for the new bridge) and levee revetment materials along the flood-side of the in-channel levee. This additional material in the river channel would cover, on aggregrate, less than an acre of additional waters.

C. Authority and Purpose. By a Resolution adopted on October 1, 1986, the U.S. House of Representatives, Committee on Public Works and Transportation, authorized a study of flooding along the Río Nigua at Salinas. The purpose of the study was to identify the source of flooding problems and identify feasible and economically viable solutions, if any.

D. General Description of Dredged or Fill Material. No dredging is proposed. The fill material will be mechanically excavated from the opposite side of the river bed and an off-site borrow area, as stated above and illustrated on Plate B-4 of Appendix B (Geotechnical Studies). Revetment would probably consist of gabion baskets.

(1) Characteristics of the material. Material to be excavated was characterized as predominantly medium density sands with varying amounts of silt and clay. Borrow site material consists generally of silty sands and silty gravels. About 95 percent of the materials obtained from the channel realignment will be suitable for levee emplacement. Unsuitable materials will be placed in the Disposal area. Revetment materials will either consist of rip-rap stone meeting Corps specifications, or gabion baskets.

(2) Quantities of Material.

(a) Required for levee within the river bed: 125,000 cu yd; (b) required excavation for pilot channel: 125,000 cu yd; c) material from (b) suitable for (a): 95% or 119,000 cu yd; (d) the remainder, about 6,000 cu yd, would be brought from the borrow area; (e)unsuitable material from the channel excavation (est. 6,000 cu yd) would be disposed of at the upland disposal site. Rocks for gabion baskets would be obtained from nearby existing quarries.

(3) Source of Material. Material would be obtained from stream bed borrow as the channel realignment progressed (excavation would proceed along the bank opposite to the levee construction). Up to 90% of the borrow material tested at the primary site may be suitable for levee construction.

E. Description of the Proposed Discharge Site.

(1) Location. The discharge site is in the city of Salinas on the south coast of Puerto Rico, close to the Highway 1 bridge which crosses Río Nigua, along the river's east bank. The site is characterized as a riparian bed. The rest of the Salinas levee, and all of Coco levee, will be deposited over uplands.

(2) Size. Aggregate area of riparian bed wetlands that would be buried is 1.9-2.9 acres, or 7,650-11,740 m^2.

(3) Type of site. Directly impacted wetlands are riparian bed (intermittently flooded). They are very sparsely vegetated by ephemeral annual herbs and shrubs and the immediate east bank is a smooth, steeply sloping concrete floodwall. At this level of the coastal plain, the river resembles a "dry wash" during most of the winter-spring dry season, with a narrow trickle of water down its center. Coarse gravel, cobbles and boulders, as well as sand and silty materials, characterize the river bed.

(4) Type of Habitat. River flow is semi-perennial at this location (flow may appear to cease during severe droughts). The shallow river flows over a gravelly and sandy bed, providing habitat for emergent annual plants and some filamentous algae. Stream fauna, not sampled, probably includes insect larvae, small individuals of river shrimp *Atya* and *Macrobrachium*, and few fish, possibly including gobies and mountain mullet. The habitat and its typical fauna are subject to regular wipe outs during heavy seasonal floods, which scour the river bottom and wash away rooted and attached vegetation.

(5) Timing and Duration of Discharge. Discharge will occur during construction, which is expected to take about two years, but construction of the realigned channel should not require more than 2 months. Directly affected wetlands will be converted to uplands (grassed levees and culverts)

F. Description of disposal method. High capacity earth moving equipment such as bulldozers, dump trucks and front-end loaders will be used.

II. Factual determinations.

A. Physical Substrate Determinations.

(1) Substrate elevation and slope. Slopes are very gradual: 0-3 per cent.

(2) Sediment type. Deposited material will be largely derived from opposite side river bed areas, and consists of sand and silty sand.

(3) Fill material movement. Fines could potentially wash out during rains or flood flows until the new levee is stabilized. A gabion revetment is planned for the flood side of the levee to avoid erosion and sedimentation of the river bed. Levee grassing of the protected side is part of the recommended plan, to minimize the period of time that levee slopes will be unprotected. Other measures to control movement of fine sediments, such as silt fences or hay ground cover, may be considered for vulnerable areas.

(4) Physical effects on benthos. No benthic organisms were observed in the east bank river bed Refer to E (4), above.

B. Water Circulation, Fluctuation and Salinity Determination.

(1) Water Column effects. This section is not applicable. The river is shallow or intermittent for long periods each year.

(2) Current Patterns and Circulation. Waters in the stream reach to be realigned are too shallow to develop current patterns. The Río Nigua is not subject to tides at the area of the floodwall. Frequent rainy season high water events scour the stream bottom, wash out living organisms, and leave a clean bottom to be recolonized by tolerant organisms.

(3) Normal Water Level Fluctuations and Salinity Gradients.

C. Suspended Particulate/Turbidity Determinations. Construction practices will incorporate measures to avoid increasing suspended particulate levels in the riparian bed. To the greatest extent feasible construction will proceed in the dry season. Turbidity levels will be maintained within EQB standards for surface waters.

(1) Expected Changes at the Disposal Site. Suspended particles from movement and discharge of fill will temporarily increase water turbidity during construction of the levee segment inside the stream bed. These effects will not persist once construction is complete, because normal flows past the levee will not be of high velocity, and erodible areas will be protected with a revetment. Construction of the levee through the riparian bed should not lead to release of significant

quantities of sediment, as long as construction is timed to avoid work during high stage and flow periods, and construction activities are stopped in the event of heavy, flooding rains. The levee segment in the channel, and other high-velocity reaches, will be protected against erosion on the flood-side by gabions. Construction of other levee segments would include grassing to stabilize side slopes and avoid sedimentation of water bodies.

(2) Effects on chemical and physical properties of the water column.

(a) Light penetration. Not applicable; the affected waters are too shallow.

(b) Dissolved oxygen. No effect expected.

(c) Toxic metals, organics and pathogens. No toxic levels of metals or organic materials are known or expected, based on a level-1 survey performed as part of the study.

(d) Aesthetics. There will be no effect.

(3) Effects on biota.

(a) Primary productivity and photosynthesis. The 1.9 acres of riparian bed that will be converted to upland will be replaced in kind and on-site (opposite side of the channel) by 1.9 acres of newly excavated riparian bed. No further mitigation is necessary.

(b) Suspension/filter feeders. No populations of this biotic group were identified in levee reaches.

(c) Sight feeders. Mobile aquatic forms will be eliminated or move away from levee deposition areas.

(d) Contaminant determinations. No contaminants or contaminated areas have been identified in the immediate vicinity of the borrow or wetland disposal areas, after a preliminary survey for indications of hazardous, toxic or radiologic waste.

(1) Endangered or Threatened Species. None inhabit the area where disposal will occur. FWS has concurred with this determination.

III. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination. Not applicable. Deposit of fill will completely dry out the east side of the channel.

Unusable material will be disposed of at the upland disposal site.

(2) Determination of Compliance with Applicable Water Quality Standards. The clean fill proposed for the project will not result in violation of any Puerto Rico water quality standards.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supplies. Waters in the Río Nigua in the study area are not used for public supply.

(b) Recreational and commercial fisheries. A few fishermen and their families reside in the community to be protected. They fish offshore banks. A small amount of recreational fishing and crabbing occur near the river mouth, and it will not be adversely affected by the channel realignment.

(c) Water Related Recreation. No effect.

(d) Aesthetics. Levees will somewhat restrict views to the west of the community, but, due to their low height and their distance from streets and houses, effects are not expected to be significant.

(e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and similar preserves. A designated Coastal Barrier Reserve encompasses the mouth of Río Nigua at Salinas. It is Segment PR-47. No activities are proposed inside this barrier unit.

(4) Determination of Cumulative Effects on the Aquatic Ecosystem. There will be no cumulative effects.

IV. Findings of Compliance or Non-compliance with the Restrictions of Discharge.

(1). No significant adaptations of the guidelines were made relative to this evaluation. The proposed alignment of the levees was chosen to minimize the footprint over all wetlands, and to avoid highly valued coastal wetlands entirely. Only a small area of riparian bed (channel bottom) wetlands will be affected, and it will be replaced on-site and in-kind along the opposite bank.

(2). No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.

(3) The discharge of fill materials will not cause or contribute to violations of any applicable Commonwealth water quality standards. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

D. The placement of fill material will not jeopardize the continued existence of any listed species or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

E. The placement of fill materials will not result in significant adverse effects on human health and welfare, municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity; productivity and stability; and recreational, aesthetic and economic values will not occur.

F. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems included selecting the plan with the least real impact on the aquatic environment.

G. The proposed disposal site (levee route inside the river channel) for the discharge of fill materials is specified as complying with the requirements of these guidelines.

ATTACHMENT C

PUERTO RICO COASTAL ZONE PROGRAM

CONSISTENCY DETERMINATION AND

APPLICATION FOR CONCURRENCE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

August 29, 1996

REPLY TO
ATTENTION OF
Planning Division
Environmental Branch

Honorable Norma E. Burgos
Chairwoman, Puerto Rico Planning Board
Minillas Station
Post Office Box 41119
San Juan, PR 00940-9985

Dear Ms. Burgos:

The U.S. Army Corps of Engineers, Jacksonville District, coordinated a Draft Feasibility Report and Environmental Assessment (EA) for flood control works along the Río Nigua de Salinas at Coco Ward and Salinas-Playa de Salinas for public and agency comment in Puerto Rico during May-June, 1996. Comments have been received from Puerto Rico and Federal agencies, and a letter of support for the project has been received from Mr. Gelabert, Secretary of the Puerto Rico Department of Natural and Environmental Resources. We have received concurrence from all commenting agencies, including the Puerto Rico Environmental Quality Board, U.S. Fish and Wildlife Service (reproduced in their Coordination Act Report), U.S. Environmental Protection Agency (EPA), and the National Marine Fisheries Service (NMFS).

In accordance with our agreements, at this time we wish to submit our determination of consistency with the Puerto Rico Coastal Management Program to the Board for review. We enclose a completed form JP-833 and copies of agencies' letters of concurrence with the Draft EA.

Thank you for your consideration.

Sincerely,

George M. Strain
Acting Chief, Planning Division

Enclosure

Sept. 84

COMMONWEALTH OF PUERTO RICO
OFFICE OF THE GOVERNOR
PUERTO RICO PLANNING BOARD
PHYSICAL PLANNING AREA
LAND USE PLANNING BUREAU

APPLICATION FOR CERTIFICATION OF CONSISTENCY WITH THE PUERTO RICO COASTAL MANAGEMENT PROGRAM

General Instructions:

A. Attach a 1:20,000 scale, U.S. Geological Survey topographic quadrangular base map of the site.

B. Attach a reasonably scaled plan or schematic design of the proposed project, indicating the following:

1. Peripheral areas
2. Bodies of water, tidal limit and natural systems

C. You may attach any further information you consider necessary for proper evaluation of the proposal.

D. If any information requested in the questionaire does not apply in your case, indicate by writing "N/A" (not applicable).

E. Submit a minimum of seven (7) copies of this application.

DO NOT WRITE IN THIS BOX

Type of application: Application number:

Date received: Date of certification:

Evaluation result: [ ] objection [ ] acceptance [ ] negotiation

Technician: Supervisor:

Comments:

1. Name of Federal Agency: U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DIST.

2. Federal Program Catalog Number: 12.106 (FLOOD CONTROL)

3. Type of Action: Civil Works (Construction of Flood Control Public Works)

[X] Federal Activity [ ] License or permit [ ] federal assistance

4. Name of Applicant: U.S.Army, Corps of Engineers, Jacksonville District (in cooperation with P.R. Dep't. of Natural&Env. Resources

Postal Address: PO Box 4970 Jacksonville, Florida 32232-0019

Telephone: (904-232-1692)

5. Project Name: Rio Nigua at Salinas Flood Control Project

6. Physical Description of Project Location: Municipio de Salinas, Barrio Coco y Playa Salinas, PR. (Along East bank of river). Two discontinuous levees. (area, facilities such as vehicular access, drainage, storm and sanitary sewer placement, etc.) Access by means of highways PR 1 and PR-52; local roads.

The Coco levee will be 4 km long; the Salinas-Playa levee will be 3 km long, extending from Highway 52-Hwy 1 intersection to the coast.

7. Type of construction or other work proposed:

drainage ( ) channeling ( ) landfill ( ) sand extraction ( ) pier ( )

bridge ( ) residential( ) tourist ( )

Other (specify and explain) This will be a publicly-funded (Federal-Commonwealth) flood control project to protect the town of Salinas as well as barrios Coco and Playa from river overbank flooding from the Rio Nigua de Salinas. The Secretary of DNER has expressed support for this project (refer to EA Coordination Attachment)

Description of proposed work: Flood protection will be provided the town by construction of two levees. At Coco, the levee will average 3.8m high and will be nearly 4 km long (along W side of PR-1 inside Camp Santiago.). At Salinas and Playa, the levee will follow the E. side of the river, entering the channel above the Hwy 1 bridge and the old railroad bridge, continue south and end inshore from the coast. This levee will grade from nearly 5 m high near PR-52 to only 1.5 m high near the coast. Project includes relocation of 35 residences, 2 bridges, and relocation of 1 secondary access road and ford over the riv

8. Natural, artificial, historic or cultural systems likely to be affected by the project Two historic bridges (hwy 1, rr) and one historic archeological site will be affected

Place an X opposite any of the systems indicated below that are in the project area or its surroundings which are likely to be affected by the activity. Indicate the distance from the project to any outside system that would likely be affected.

No wetlands, forests or other natural resources will be affected.

System	Within Project	Outside Project	Distance (meters)	Local name of affected system
beach, dunes				
marshes				
coral, reefs				
river, estuary	x R. Nigua			This is a river corridor project.
bird sanctuary				
pond, lake, lagoon				
agricultural unit				
forest, wood				
cliff, breakwater				
cultural or tourist area				
other (explain				
Historic sites (3)	(3)			Hwy 1 bridge; railroad bridge, historic site

Describe the likely impact of the project on the identified system (s) .

Positive ☐ Negative ☒ RR bridge to be removed;

Explain: Highway bridge will be replaced by higher bridge; historic archeological site is in "footprint" of levee and will be covered over; mitigation will be by HAER documentation of bridges and study of hist. arch. site. SHPO has concurred.

9. Indicate permits, approvals and endorsements of the proposal by Federal and Puerto Rican government agencies. Evidence of such support should be attached to the proposal.

	Yes	No	Pending	Application Number
a. Planning Board	( )	( )	( )	
b. Regulation and Permits Administration	( )	( )	( )	

	Yes	No	Pending	Application Number
c. Environmental Quality Board	(x)	( )	( )	Refer to EA
d. Department of Natural Resources	(x)	( )	( )	Project local sponso
ke. State Historic Preservation Office	(x)	( )	( )	Letter of concurrenc
f. U. S. Army Corps of Engineers	( )	(x)	( )	This is COE Project!
g. U. S. Coast Guard	( )	( )	(x)	Has Been notified
h. Other (s) (specify)	(x)	( )	( )	U.S. EPA (concurred)
FWS	x			Concurred (Ref. EA)

CERTIFICATE: I certify that (project name) Rio Nigua at Salinas Flood Control Project is consistent with the Puerto Rico Coastal Zone Management Program, and that to the best of my knowledge the above information is true.

(Signed) George M. Strain

(Position) Acting Chief, Planning Division
U.S. Army Corps of Engineers
Jacksonville District

DATE: 4 Sept 96

**Rio Nigua at Salinas, Puerto Rico
Evaluation of Consistency with Puerto Rico Coastal Management Program**

Name of Project: Rio Nigua at Salinas, Puerto Rico, Flood Control Project, as proposed in Feasiblity Study Report and Environmental Assessment.

Type of Project: A cost-shared (Federal-Commonwealth flood control project). The project is recommended by a study funded jointly by the U.S. Army Corps of Engineers, Jacksonville District (USACE) and the Puerto Rico Department of Natural and Environmental Resources (DNER). The study was authorized by a Resolution of the U.S. House of Representatives. The recommended flood control project would protect Salinas (including the "Playa de Salinas" ward) and El Coco rural community. The recommended plan is supported by a Feasibility Study Report and Environmental Assessment (attached).

Project Sponsor: If the project is approved, the sponsor would be the USACE and the co-sponsor would be DNER. As alternative plans were developed, the co-Sponsor (DNER) assisted in identification of significant natural resources of the study area, as has the U.S. Fish and Wildlife Service (FWS). An EA has been prepared for the flood control plan recommended by the Study. The project is located in part in the coastal zone of Puerto Rico, which includes the estuary of the Río Nigua at Salinas, which begins a short distance south of the Highway 1 bridge and continues to the river mouth.

Project Description : The recommended plan would protect El Coco rural community and the town of Salinas, including Playa de Salinas, from river overbank flooding, by means of two (unconnected) earthen levees. The downstream levee would begin upriver of Highway 52 on the east bank of Río Nigua, and would extend to the north side of the Highway overpass. Beginning again on the south side, it would extend to the coastal berm. A second levee, also on the river's east bank, would protect "el Coco" rural community, located about 3 km upstream near the east bank of the river. This levee is not inside the coastal zone. Both levees would be of earthen construction with a 3 m crown and 2.5 horizontal on 1 vertical side slopes. The Salinas levee would be about 3 km (1.8 mi) long and average 4.5 m (15 ft) above ground elevation at its northern end, diminishing gradually to only 1.5 m (5 ft) high near the coast. Other project features include removal of channel obstructions, including an old concrete ford and the historic Highway 1 bridge and railroad bridge over the river. Minor channel realignment, involving levee construction inside the channel and excavation of the opposite (west) bank, will be necessary near this bridge to provide conveyance, and will require removal of an estimated 35 residences on the west bank. Other project features include installation of several culverts in the levee for interior drainage, and re-routing of access to structures on the west river bank by means of a new road, which will run north from Highway 1, on the west side of the river bridge, along the west bank to provide access to a commercial quarry and therapeutic community. There would be no adverse effects on wetlands, Natural Heritage elements, threatened or endangered species, wildilfe or fisheries. Cultural resources that would be adversely affected include the historic Highway 1 bridge, a historic archeological site on the coast, and the old sugar cane railroad bridge located south of Highway 1. The railroad bridge is scheduled for removal by the Commonwealth prior to project construction. If it is not removed, it will be documented, as will the Highway 1 bridge, to Historic American Engineering Record (HAER) standards. Further cultural resources investigations would include documentation of the historic archeological site and documentation of significant vernacular architectural elements in the residences to be removed, if any.

A gasoline station with an underground storage tank, located near Highway 1 east of the river bridge, may also be in the project footprint. It is not known if the subterranean tank will require removal for the project levee, or if it can be avoided. In case tank removal proves necessary, a funding estimate has been included for this work and any required remediation. However, at this time there is no indication that the existing tank is not functioning properly.

Borrow and disposal sites are upland areas that are outside the coastal zone. The Coco levee is also outside the Coastal Zone.

Probable Effect of the Project on Coastal Natural Resources. Significant coastal resources at the river mouth include mangrove forests, the river estuary itself, salt marsh emergent wetlands and undeveloped coastal dunes inside a Federally designated Coastal Barrier Resource Segment (PR-46). Early identification of these resources allowed the project levee to be designed so that it would not impact them. These areas will be ***avoided*** by the coastal levee, which has been aligned so as to pass to the east of the estuary and the Coastal Barrier, through uplands. An estimated 1.9 acres of the east bank of the river bed will be filled by the Salinas levee above the estuarine zone; but an equal area (1.9 acres) of the west river bank will be graded down to form a new riparian bed on the opposite side of the river, so that the stream will have the same conveyance as at present. Because adverse affects to coastal wetlands have been avoided, no wetlands mitigation is necessary.

The project will not cause secondary or indirect adverse impacts to the coastal resources, because it will not diminish or increase the volume or timing of waters arriving at the coastal zone, nor will it cause adverse changes in water quality.

Permits Required: A Corps of Engineers permit will ***not*** be required for the proposed action. This is a Federally funded civil (public) works project, not a permit action. The attached Feasibility Study Report and EA explain subsequent steps to be taken by the Corps of Engineers and the co-sponsor.
A Water Quality Certificate will be required from EQB and will be applied for when the EA coordination is complete.
An N.P.D.E.S. permit or waiver will be required from U.S. EPA.
Incidental permits required from EQB prior to construction include: C.E.S.T. plan permit, Fugitive Dust permit, Solid Waste Generators' permit. These incidental permits are obtained by the Contractor.

Relationship between the proposed project and the Puerto Rico Coastal Management Plan Policies. The Coastal Zone Management Program recognizes various flood protection strategies, including public education, protecting flood-prone areas from development, Federal Flood insurance programs, and early warning systems coupled with flood evacuation. An early warning and evacuation system is available for Salinas, but the lead time is very short, risking the chance of loss of life if evacuation is not completed quickly. The CZMP policy for people who already live in floodable areas is construction of flood control works to avoid property damage and loss of life, and, where necessary, relocation (NOAA 1977). The Río Nigua study was undertaken at the request of the Governor of Puerto Rico, and it considers all economically viable and hydraulically efficient alternatives for flood protection. The proposed plan recognizes the need to protect presently developed areas, while avoiding expansion of development into adjacent flood-prone areas.

Therefore, the U.S. Army, Corps of Engineers has determined that the recommended plan is consistent.

ATTACHMENT D

FISH AND WILDLIFE COORDINATION

ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Caribbean Field Office
P.O. Box 491
Boqueron, Puerto Rico 00622

August 14, 1995

Mr. A. J. Salem
Chief, Planning Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232

Dear Mr. Salem:

Enclosed is our Coordination Act Report for the Rio Nigua at Salinas Flood Control Project. This report constitutes fulfillment of Section 2(b)of the Fish and Wildlife Coordination Act. If you have any questions please feel free to contact us.

Sincerely,

Felix Lopez
Acting Field Supervisor

fhl
cc:
COE, San Juan
DNR, San Juan

Executive Summary

The US Army Corps of Engineers is proposing to reduce flooding and flood damage to the communities of Coco and Playa de Salinas from the Rio Nigua. Current plans call for a levee for the Coco Community in the upper portion of the Rio Nigua. Measures for the lower portion of the town and the Playa Salinas area have been revised. Plans now call for downsized levees and the elimination of the proposed relief channel while still providing SPF level of protection (See Fig. 1 & 2).

The direct project impacts to fish and wildlife resources caused by the proposed levee route will be minimal since most of the alignment is abandoned agricultural fields and urban areas. Impacts to fish and wildlife resource for the upper portion of the project are negligible since the levee will be built within the existing boundaries of the Camp Santiago military base. Impacts to wetlands will be avoided at the end of the levee by its reduction in footprint.

The Playa Salinas segment will include only a levee, along the town. Fish and Wildlife concerns with the maintenance of flow in the wetlands associated with the current river mouth and the designated Coastal Barrier PR-47 have been adequately addressed by the elimination of the diversion channel and reduction of the levee.

This report constitutes fulfillment of Section 2(b) of the Fish and Wildlife Coordination Act, and constitutes a final report as required by the Act.

Project Description

The US Army Corps of Engineers is proposing to reduce flooding and flood damage to the communities of Coco and Playa de Salinas from the Rio Nigua. Current plans call for a levee for the Coco Community in the upper portion of the Rio Nigua and channel improvements, and a levee for the lower portion of the town and the Playa Salinas area. Service coordination on this project includes several site visits, a review of the Corps Reconnaissance Report in August 1990, and participation in the scoping process.

Description of Study Area

The Rio Nigua is located on the south coast of Puerto Rico. This area is designated as sub-tropical dry forest with a rainfall range between 600-1000 mm a year. Rivers in this area are known to have periods of very low or no flow. As a result, a sand berm usually blocks the river mouth during months of little rainfall. This berm is broken during the first large flood of the season. Estuarine, riverine and basin mangroves are common in these systems as well as salt flats and seasonal salt marshes.

The area to be impacted in the Cocos Community is located within the Camp Santiago base property. The proposed levee will follow the existing security fence alignment. The area is mostly grass land with isolated individual trees. There are no significant areas of wildlife concern.

The Playa Salinas sector consists mostly of urban development. In some areas this development goes right up to the river bank. Vegetation along the river bank is limited and severely impacted by development. The river channel has been extensively modified by Municipal flood control measures which includes the widening of the channel with bulldozers. The proposed levee will cross through an area that consists of abandoned agricultural lands. Although rows and furrows are still visible on the ground, this area has been colonized by rapid growing weedy species and thorn scrub. A small saltflat area associated with a tidal creek would have been impacted by the previously proposed project. Current project dimensions will avoided impacts to wetlands through downsizing .

Soils: Soils in the lower portion of the project site consist of Arenales sandy loam (Ar), Cobbly Alluvial Land (Cn), Vayas Silty Clay (Vc), Guamani Silty Clay (Gm), Meros Sand (MrB) and Tidal Flats (Ts). Of these soils, Cobbly alluvial land, Meros sand and Vayas silty clay are known to have hydric inclusions. Tidal flat is a hydric soils.

The proposed levee will impact Arenales, Cobbly Alluvial, Guamani, Vayas, and Meros soils. Saltflat vegetation is probably associated with the Vayas or Meros soils.

Existing Resources

Wetlands: Very little wetlands exist within the project area. Riverine wetlands are restricted to the Rio Nigua channel only. The banks of the Nigua are fairly steep in some areas. At other areas, the banks have been broadened by local flood control efforts. Bank vegetation is comprised of scrub with very few trees. Wetland vegetation within the river is comprised solely of grasses. The estuarine area of the river is comprised of red (Rhizophora mangle) mangroves along the banks with a basin forest dominated by black (Avicennia nitida) and white mangroves (Laguncularia racemosa) on either side. This area is also designated as a Coastal Barrier (PR-47). Periodic flooding of this area is necessary to the system's ecological well being, flood waters flush the area and provide the hydrology for the adjacent basin mangroves.

A tidal creek is located just east of the project. This creek has restricted flow and flushing because of a poorly designed culvert and bridge. Extending from the creek are seasonal wetlands comprised of cattails (Typha domingensis) grading into a small salt marsh comprised mostly of sedges (Fimbristylis sp), and salt grass (Sporobolus virginicus).

Uplands: Upland vegetation is restricted to scrub/shrub vegetation comprised of turpentine tree (almácigo Bursera simaruba), mesquite (bayahonda, Prosopis juliflora), tachuelo (Pictetia aculeata), ucar (Bucida buceras), tantan (Leucaena glauca), cat's claw (Pithecellobium unguis-cati). In some areas this vegetation has formed a thicket. The lower portion of the levee pass through this type of vegetation. The Camp Santiago section is comprised of upland grasses with occasional individual trees.

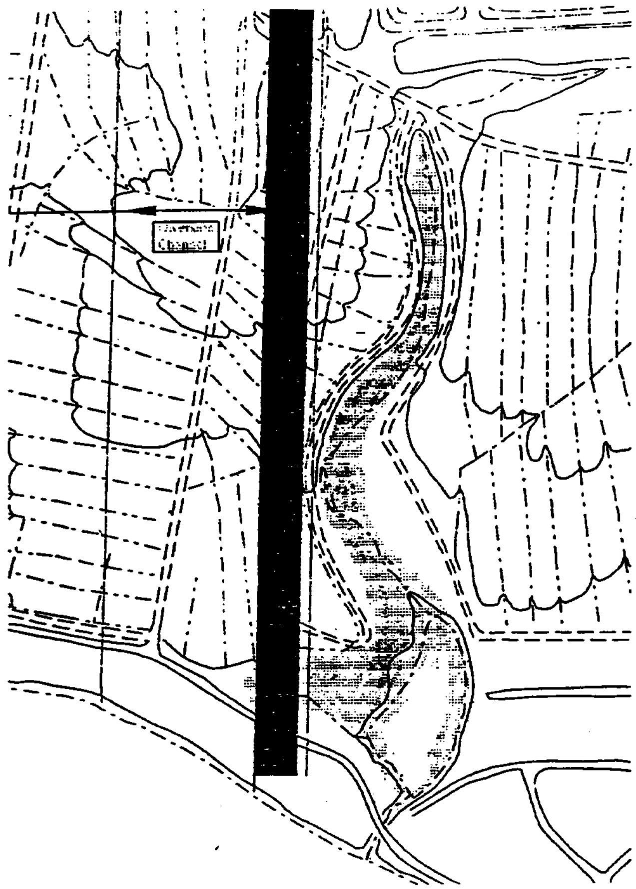
Wildlife: Avifauna forms the bulk of the wildlife resources for the area. The Rio Nigua provides foraging habitat for numerous wading birds such as herons and egrets. The estuary provide fishery habitat as well as wildlife habitat. Most of the wildlife resources are associated with the Rio Nigua proper. Wildlife habitat away from the river has been severely degraded by urban development and agriculture.

Endangered Species:

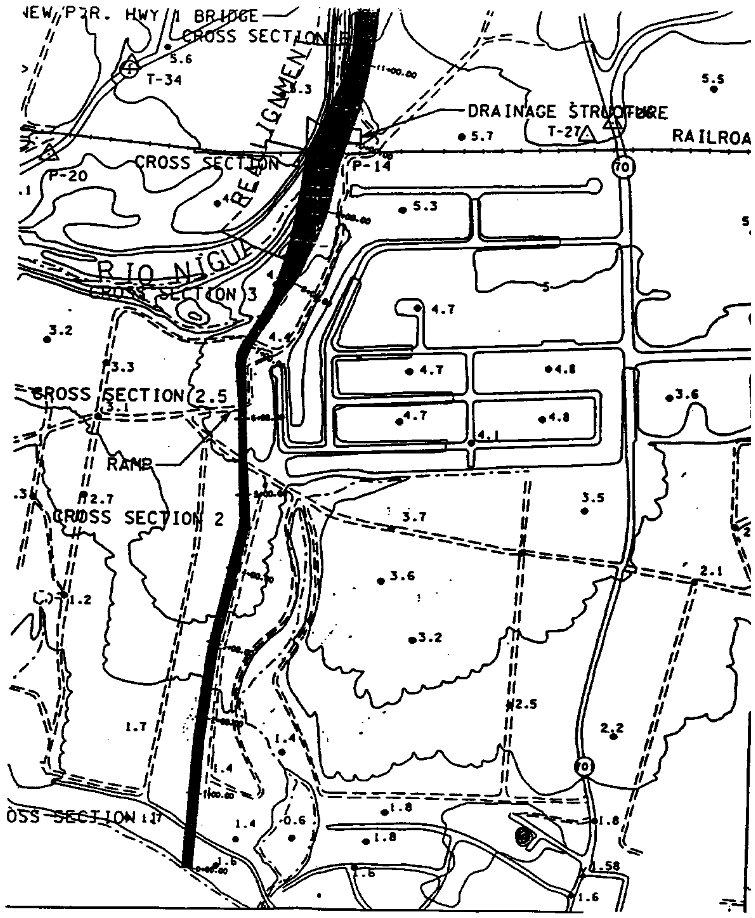
The proposed project site falls within the range of the Antillean manatee (Trichechus manatus manatus) and the yellow-shouldered blackbird (Agelaius xanthomus), both species are designated as endangered under the Endangered Species Act of 1973 as amended. The beach front of the area has been occupied by coastal development and the remaining beaches within the project site may not be suitable for nesting seaturtles. Because no construction will extend into the marine ecosystem, adverse impacts on manatees are not expected. The mangrove areas along the banks of the river and creek may harbor yellow-shouldered blackbirds and provide roosting and nesting habitat. However, mangroves will not be directly impacted by the project and adverse impacts to the yellow-shouldered blackbird are not expected.

Project Impacts

Without the project the Salinas community will probably continue to suffer from periodic short term flooding from the Rio Nigua. The project's impacts to fish and wildlife resources and habitat will be negligible because of the area's development. Impacts to the estuary has been minimized by eliminating the diversion channel. Impacts to wetlands by the levee have also been avoided by the projects new dimensions.



Previously proposed Flood Control Measures



Currently proposed Flood Control Measures

FINDING OF NO SIGNIFICANT IMPACT
RIO NIGUA AT SALINAS, PUERTO RICO FLOOD CONTROL STUDY
AND RECOMMENDED PROJECT

I have reviewed the revised Feasibility Report and Environmental Assessment (EA) prepared at the conclusion of the Flood Control Study, which recommends the proposed action. Based on information analyzed in the Report and EA, reflecting pertinent information obtained from other agencies and special interest groups having jurisdiction by law and/or special expertise, and based further on comments and recommendations obtained after coordination of the above report, I conclude that the proposed action will have no significant impact on the quality of the human environment. Reasons for this conclusion are, in summary:

1. There will be no adverse impacts to endangered or threatened species of flora or fauna, wetlands or significant fish or wildlife populations or habitats. Responsible resource agencies have concurred with this determination.

2. Water quality will not be adversely affected. Commonwealth Water Quality Standards will be met and a Water Quality Certificate (WQC) will be requested from the Puerto Rico Environmental Quality Board (EQB). By letter dated 30 July, 1996, EQB accepted the Draft EA and indicated willingness to accept WQC application. The United States Environmental Protection Agency (EPA) has concurred with the EA.

3. Three significant historic resources may be affected by the recommended project alignment. Two of these resources, historic bridges, must be removed before or during project construction, and mitigation for this adverse effect will be by documentation of the structures to Historic American Engineering Record (HAER) Standards. The third resource is a historic archeological site that may lie partly in the footprint of the Salinas levee. Preferred mitigation for this resource is avoidance; mitigation for impact, if avoidance is not feasible, will be by additional studies and documentation. The State Historic Preservation Officer (SHPO) has concurred with the Corps determination that if avoidance is not feasible, documentation of the resources constitutes adequate mitigation.

4. The project has been determined to be consistent with the Puerto Rico Coastal Zone Management Program. A Determination of consistency was included as an Attachment to the EA. An application for CZM concurrence has been submitted to the Puerto Rico Planning Board, subsequent to EQB's approval of the Draft EA. Planning Board concurrence is expected because no Puerto Rico government agency objects to the project.

5. A level-1 survey and assessment for the presence of hazardous, toxic or radiologic waste materials (HTRW) was carried out in 1993 and updated in December, 1995. No HTRW materials are known or

indicated in the project footprint. A gasoline station that may be affected by the lower Salinas levee includes an underground storage tank. The tank is not a known source of contamination but it may fall inside the levee footprint; hence, removal cost for this tank and remediation costs are included in the project cost estimate as a worst-case contingency.

6. Public benefits include improvement of public safety and elimination of property losses due to high stage, low frequency floods. Additional direct economic benefits include flood protection of high-value winter crops, increased employment and advanced replacement of a highway bridge. Adverse effects are all related to the construction phase of the project and include minor changes in noise levels and traffic congestion. These transitory adverse effects will cease when the project is built, and they will be minimized by close monitoring of construction staging and sequencing.

In consideration of the information summarized, I find that the proposed action will not significantly affect the human environment and does not require an Environmental Impact Statement.

10 Sep 96
(Date)

for TERRY L. RICE
Colonel, U.S. Army
District Engineer

James A. Connell
Lieutenant Colonel, U.S. Army
Acting District Engineer

RIO NIGUA AT SALINAS, PUERTO RICO

FEASIBILITY REPORT

APPENDIX A

HYDROLOGY AND HYDRAULICS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

I. INTRODUCTION

This appendix provides a description of the study methods associated with the hydrologic investigation of the Rio Nigua drainage basin. It further presents the resulting data that define the hydraulics of Rio Nigua in the vicinity of Salinas, Puerto Rico.

II. RIO NIGUA AT SALINAS, PUERTO RICO

The analyses and data that follow define the existing flooding conditions for the Rio Nigua at Salinas Feasibility Study. The study reach extends from the mouth of Rio Nigua, past the town of Salinas, to the town of Coco, Puerto Rico - a distance of approximately 7 kilometers. Additionally, this section presents the hydrologic data that reflect a consideration of future conditions development in the Rio Nigua drainage basin. Rio Nigua and its tributaries are shown on Figure A-1.

A. The Rio Nigua Drainage Basin

1. Description of the Watershed

Rio Nigua completes the run to the sea and joins Mar Caribe as it discharges its flow into Bahia Rincon, approximately 1.5 kilometers southwest of Salinas, Puerto Rico. Salinas is located on the southern coast of the island, about 33 kilometers East of Ponce, the second largest city in the Commonwealth. Rio Nigua and its tributaries drain a basin that covers approximately 142 square kilometers. The climate is warm and dry. The average temperatures are 26.6 degrees Centigrade for the year, 24.9 degrees for January, and 27.8 degrees for July. The average annual rainfall ranges from 61 to 114 centimeters from the coastal plains to the more upper reaches. The basin, in large part, embraces the southern slopes of the Cordillera Central, that longitudinally oriented mountain system that divides the island, North from South, and forms the major hydrologic surface water divide. The peaks and main escarpment of the Cordillera Central range between 750 and 1200 meters above mean sea level. The highest point in the Rio Nigua drainage basin is at an elevation of approximately 860 meters above mean sea level. The upper reaches of the basin that drain the mountain slopes are steep, and they drain very quickly. That gradient progressively moderates as the channels converge in the foothills and form the braided streams that cross the coastal plain. Puerto Rico Highway 52 enters the basin from the west at a point about 2.5 kilometers north of the coast. It meanders toward the southeast and passes near the northern limits of

Salinas, where it begins a broad sweeping turn toward the northeast. The highway continues parallel with the eastern basin edge as it ascends from the coastal plain into the foothills. Near Rabo del Buey, it enters the central portion of the watershed and rises northeasterly through the mountains to cross the basin divide about 17 kilometers northeast of Salinas.

2. Topography

The upper Rio Nigua drainage area is predominantly mountainous. The highest peak in the basin is approximately 860 meters above mean sea level. As the river flows southerly, it descends from the highlands, transits the foothills, and crosses one of the most distinctive alluvial fans on the south coast of Puerto Rico. Approaching Salinas, the slope flattens to approximately 3.7 meters per kilometer, as the river continues across the coastal flood plain, breaches the small estuary, and exits to the sea.

3. Tributaries

Two major tributaries combine with Rio Nigua to produce the total discharge that flows from the mouth into the sea. Rio Lapa drains an area of approximately 32 square kilometers, and joins the system near the town of Rabo del Buey, 8.4 kilometers upstream from Salinas. Rio Majada drains approximately 61 square kilometers, and flows into Rio Nigua 6.1 kilometers northeast of Salinas, just north of the town of Coco.

4. Soils

The document, "Soil Survey of Humacao Area of Eastern Puerto Rico", published by the United States Department of Agriculture Soil Conservation Service, delineates the various soil associations within the Rio Nigua basin, on aerial photography maps. There are three predominant soil associations in the Rio Nigua watershed. Coamo-Guamani-Vives association: Deep, well-drained, nearly level to strongly sloping soils on terraces and alluvial fans. This soil type is classified in hydrologic soil group B. Descalabrado-Guayama association: Shallow, well-drained, strongly sloping to very steep soils on the volcanic uplands. This soil type is classified in hydrologic soil group D. Jacana-Amelia-Fraternidad association: Moderately deep and deep, well-drained and moderately well-drained, nearly level to strongly sloping soils on terraces, alluvial fans, and foot slopes. This soil type is classified in hydrologic soil group D. The subbasins in the Rio Nigua watershed with their associated predominant soil type are listed in Table A-1.

5. Available Hydrologic Data

The Water Resources Division of the US Geological Survey, in cooperation with local and other federal agencies accumulates extensive data pertaining to the water resources of Puerto Rico. This information is collected at streamflow gaging stations, water quality stations, and ground water observation wells throughout the island, and compiled each water year for publication under the title, Water Resources Data Puerto Rico and the US Virgin Islands. The data may contain measurements of discharge, stage, sediment, water quality, and ground water level. Some streams have been monitored and records have been maintained for more than 25 years. The Rio Nigua basin has two streamflow gaging stations currently collecting discharge and stage information (two other stations are no longer in service). In general, streamflow gages for Rio Nigua and its tributaries are characterized by short periods of record. The basin's streamflow stations are summarized in Table A-2; they may be located in the basin on Figure A-2.

6. Flood History

Hydrologic Investigations Atlas HA-447, Floods in Salinas Area, Puerto Rico by William J. Haire, and published by The United States Geological Survey reports that floods occurred on most streams in Puerto Rico during the period October 5-10, 1970. However, the greatest floods were experienced throughout the area east of a line connecting Arecibo to Ponce, which approximates the eastern two-thirds of the island. The entire drainage basin of Rio Nigua lies within this region. Higher floods have occurred in other years in some areas, but the floods of October 1970 were notable for their duration and multiple peaks. The volume of runoff was unusually large. The floods were the result of rainfall that totaled as much as 89 centimeters, at some places, during the 6-day period. The peak discharge of Rio Lapa near the mouth during the flood of October 1970 was 207 cubic meters per second (cms), an average of 8.1 cms per square kilometer of drainage area. The peak discharge of Rio Majada near its mouth was 368 cms, an average of 6.3 cms per square kilometer. The flood of August 1956 was slightly higher than the 1970 event. The September 1928 flood, however, was 1 to 1.5 meters higher than the 1970 flood in the upper part of the coastal plain, and from 0.5 to 1 meter higher near the coast. The 1928 event was associated with the severe tropical depression, hurricane San Felipe, that crossed the island on September 13. The United States Department of Commerce publication, Climate of Puerto Rico and US Virgin Islands, by Robert J. Calvesbert, reports that the intensity of the storm, exemplified by the strength of the maximum winds (measured at 258 kilometers per hour in San Juan), was responsible for 300 fatalities and 50 million dollars in crop and property damage along its path from Aquirre, near the southeast of the island, to Aquadilla, on the northwestern shore.

Flood Atlas HA-447 indicates that other notable floods occurred at Salinas, with Rio Nigua out of its banks, during the years 1899, 1933, 1936, 1949, 1960, and 1961.

7. Rainfall

The US Department of Commerce Weather Bureau has published Technical Paper No. 42, Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands. This report presents rainfall data for various hydrologic design problems involving areas up to 1,036 square kilometers and rainfall durations up to 24 hours. Included in the report are generalized estimates of Probable Maximum Precipitation (PMP) from cloudbursts and from hurricanes, and rainfall-intensity-frequency data for return periods from 1 to 100 years. Many meteorological data measuring stations are maintained throughout the island. A total of 102 Puerto Rican stations which take precipitation observations once daily were used in the frequency analysis. Technical Paper No. 42 presents the rainfall-intensity-frequency data on a series of isopluvial maps that depict rainfall intensity as precipitation contours. The series is arranged by storm duration and probable storm return period.

Table A-3, Average Point Rainfall for the Rio Nigua Basin was developed from the rainfall intensities shown on the isopluvial maps in TP-42. Hypothetical storms used by the runoff model for Rio Nigua basin response analysis were generated from the data in this table. The model converts 50, 20, and 10 percent frequency rainfall from the table to annual series rainfall, and point rainfall depths from the table are reduced to reflect sub-basin area over which the storm is experienced. The total storm is automatically distributed according to the specified depth per duration data. A triangular precipitation distribution is constructed such that the depth specified for any duration occurs during the central part of the storm.

III. HYDROLOGY

A. HEC-1 Flood Hydrograph Model

The Army Corps of Engineers flood hydrograph model (HEC-1) was used to simulate the surface runoff response of the

Rio Nigua basin to precipitation. The model accomplishes this simulation through the generation of streamflow hydrographs for critical locations along the Rio Nigua stream system. The hydrographs represent a complete time distribution of runoff. This time series discharge data is essential for an engineering analysis of the river's reaches during low flows and flooding conditions, because it contains important information about peak discharge and total runoff volume. Model development assumes that the river and its basin may be represented by an interconnected network of hydrologic and hydraulic elements. Further, the characteristics of these elements may be expressed in terms of numerical parameters, and the relationships of each element within the network are mathematically understood. HEC-1 is capable of analyzing runoff response to natural or synthetic storms, and the user may select from a variety of internal runoff and routing algorithms to perform these analyses.

B. Formulation of the Rio Nigua Basin Runoff Model

The hydrology of the Rio Nigua basin may be understood in terms of the primary components that interact within the framework of the HEC-1 runoff model. Synthetic, spatially reduced, distributed storms of various frequencies affect an area with a runoff potential coefficient directly related to overland runoff travel times to produce streamflow discharge hydrographs at critical stream locations.

1. Drainage Area

Standard USGS 1:20,000 scale, 7.5 minute series, topographic quadrangle maps of Puerto Rico were examined to delineate the overall boundaries of the Rio Nigua watershed. The watershed was then subdivided into smaller units that were assumed to be hydrologically similar throughout, and therefore capable of being represented by model parameters that reflect average conditions. This subdivision produced 10 subbasins. Each of the subbasins was measured to determine its area for input to the model. The Rio Nigua watershed and its subbasins are shown on Figure A-1. Subbasin characteristics are identified on Table A-4.

2. Curve Numbers

The Soil Conservation Service of the US Department of Agriculture has developed a soil classification system that assigns soil types to hydrologic soil groups, and relates drainage characteristics of soil groups to a curve number. The soils of Puerto Rico have been examined in terms of this scheme. A curve number for each subbasin was calculated based on predominant hydrologic soil group after consideration of soil cover, land use type, and antecedent moisture condition. Table A-1 shows Soil Conservation Service runoff curve numbers and associated predominant soil types for each subbasin.

3. Lag Time

Time of concentration is the time required, during a storm, for the entire basin area to contribute to the surface water outflow. The time of concentration is affected by the watershed's surface conditions, land slopes, soil types, and surface water management. Mannings equation for velocity of open channel flow was used to calculate concentration times for each subbasin. A lag time for each subbasin was then determined from the relationship, lag = (0.6) x (time of concentration). Subbasin lag times appear in Table A-4.

4. Existing and Future Hydrologic Conditions

Land use changes and significant alterations to slope and topography within a drainage basin can affect the hydrologic response of that basin to rainfall. Possible future land use and topography changes were considered for each of the Rio Nigua subbasins. The upper reaches are steep and rugged, and little change is anticipated. The mid reaches are mostly within the boundaries of Camp Santiago, and are expected to experience little developmental change. The land within the limits of Coco and the town of Salinas itself were considered to be the two most likely areas that may experience changes of hydrologic significance. The subbasins that contain those two areas were parameterized for possible future conditions development, and the hydrologic model was again run to provide future conditions discharges. There was no significant difference between these discharges and those produced for existing conditions. Therefore, the discharges shown on Table A-5 are applicable for both existing and future conditions.

5. Discharges

Rainfall depth per duration data taken from Technical Publication No. 42 for storms ranging in frequency from 50 percent exceedance to 1 percent exceedance was combined with subbasin hydrologic and hydraulic parameters within the framework of HEC-1. An SPF rainfall assumed to be 125 percent of the 100-year storm was also analyzed by the model. Existing conditions routed peak discharges for these storms at locations along the Rio Nigua Stream network determined to be critical for analysis of the system appear in Table A-5. Flood hydrographs for these same storms at the mouth of Rio Nigua are shown in Figure A-3.

Data from a comparison of discharges recorded at station number 1007 (Rio Majada at Rabo Del Buey), discharges predicted by regional regression equations, and discharges estimated by the HEC-1 runoff model appear in Table A-6. A reiteration of this comparison is presented graphically by the flood flow frequency curve in Figure A-4.

6. Hydrology of Interior Flooding

This analysis addresses the management of interior surface runoff from areas that are protected by project levees, reflecting future conditions development. Culvert outlet structures that allow for drainage of interior areas to Rio Nigua are provided for the town of Salinas. Levee sections that protect the town of Coco do not prevent drainage of interior acreage to Rio Nigua. Those areas drain naturally away from the adjacent reaches of the river. US Army Corps of Engineers Hydrologic Engineering Center Interior Flood Hydrology (HEC-IFH) Package was used for the analysis of the interior flooding hydrology.

HEC-IFH is a comprehensive computer program that performs all of the components of an interior flooding analysis. It is a framework on which the analyst can model rainfall-runoff, routing, interior ponding, and gravity outlet performance, as a dynamic, interactive simulation that includes changing flood conditions in the receiving stream. For this study, interior area flood elevation-frequency relationships were determined for various alternative gravity outlet configurations by using design storm event analysis in combination with interior area runoff parameters that reflect future conditions development. The resulting runoff was routed through existing interior ponding areas adjacent to the project levees, and then through gravity outlet culvert structures draining to Rio Nigua. Coincident exterior flood stage hydrographs for the with-project condition were used for the tailwater boundary condition affecting each culvert.

No minimum facilities for interior drainage were identified in the pre-project condition. Existing conditions flood stages were used to define minimum gravity outlet facilities that would drain the protected areas before those stages were exceeded. Hydraulic design data for interior drainage culverts are listed in Table A-9. Interior flooding stages resulting from a 10-year storm are compared with existing conditions flood stages at three locations along the line of protection in Table A-10.

C. Other Sources of Flooding

The detailed study area can also be flooded by hurricane tides from the Caribbean Sea. The tide frequency elevations, as listed in Table A-12, were taken from the report, "Study for Federal Insurance Administration", prepared by the National Oceanic and Atmospheric Administration, August 1973. Tidal flooding effects were not considered in the analysis, they were treated as another source of flooding. Tidal flood protection was not within the scope of the riverine protection project but could be added in the future without an adverse impact on the proposed plan.

IV. HYDRAULICS

A. Existing Conditions

1. Hydraulic Modeling

Existing conditions were analyzed using the Hydrologic Engineering Center program entitled HEC-2. This program uses the standard step backwater computation approach for computing water surface elevations. Attempts to use UNET proved unsuccessful due to the steep slope in the study area. Computer modeling of the existing flood plain showed that most of the flood flow is conveyed through the overbank areas of the flood plain.

In establishing a mathematical model representing existing conditions, the study area was divided into a lower and upper reach. The lower reach model analyzed the existing and with project conditions for the town of Salinas and the community of Playa de Salinas. The upper reach model analyzed the existing and with project conditions for the community of Coco.

The lower reach model starts from the mouth of Rio Nigua and continues northeasterly up to PR Hwy 52. This model has a total of sixteen cross sections and their locations are indicated on Plate A-1. A railroad and two highway bridges, PR Hwy 1 and 52, were also modeled. The normal bridge routine was used to describe the flow through the railroad and PR Hwy 1 while the special bridge routine was used for the PR Hwy 52 bridge.

The upper reach model starts north of PR Hwy 52 and ends north of the community of Coco. The cross sections were numbered sixteen through twenty-five and their locations are indicated on Plates A-1 and A-2. There is a five barrel culvert structure at PR Hwy 154 and the special culvert method was used to analyze the flow through this structure.

2. Topographic Data

The town of Salinas and the community of Playa de Salinas were surveyed in May 1981 and topographic maps were prepared on a scale of 1 to 5,000 with a contour interval of 1 meter. Data for the railroad and bridges at PR Hwy 1 and PR Hwy 52 were obtained by additional surveys and drawings from the Puerto Rico Highway Authority.

For the community of Coco the detailed study area was surveyed in September 1992 and topographic maps were prepared on a scale of 1 to 10,000 with a contour interval of 5 meters. Data for the five barrel culvert structure at PR Hwy 154 were obtained by additional surveys.

3. Roughness Coefficients

For the computer model of the lower reach the Manning's "n" value ranged from .01 to .275 for the channel and .05 to .48 for the overbank areas.

For the computer model of the upper reach the Manning's "n" value ranged from .03 to .08 for the channel and .05 to .18 for the overbank areas.

4. Starting Conditions

The starting water surface elevation used for the calibration was .68 meters which corresponds to a 10-year potential storm tide for the south coast near Salinas.

5. Model Verification

A Hydrologic Investigations Atlas HA-447 for the October 1970 flood was prepared by the USGS. This investigation indicates the location and elevation of the high water marks and estimated flood stage contours for this flood. The hydrologic analysis indicated that the October 1970 flood corresponded to a 10-year event. The HEC-2 models were therefore calibrated to that event.

6. Flood Stages

The flood hydrographs for frequencies ranging from a 50 percent chance flood event to a SPF event were routed through the HEC-2 models. Plates A-1 and A-2 show the existing conditions flooded areas. Table A-7 shows the water surface elevations for the lower and upper reaches under existing conditions.

7. Comparison to Federal Emergency Management Agency Study

The Federal Emergency Management Agency (FEMA) completed a study of the Majada River Basin in August 1986. Figure A-5 compares the 100-year water surface elevation from the HEC-2 models with the results from the FEMA study.

B. With Project Conditions

1. General

The existing condition HEC-2 model was modified by blocking the flow areas east of the proposed levee alignment to represent the with-project conditions. Plate A-3 through A-5 indicate the recommended plan for this project. Plates A-6 and A-7 show the flooded areas with project for the 10-year and SPF events.

2. Levee

Proposed project design feature consist of three levee segments which provide flood protection for the town of Salinas and the communities of Playa de Salinas and Coco. Each levee segment is described as follows:

a. First Levee Segment

The first levee segment would protect the town of Salinas and the community of Playa de Salinas. This levee segment would start from the coastline and end at the southeast abutment of the PR Hwy 52 bridge over Rio Nigua. Total length of this levee segment is about 2,963 meters. The levee side slopes would be 1 vertical and 2.5 horizontal with a minimum crest width of three meters. The side slopes of the proposed levee segment were based on existing soil conditions, type of material used in construction, and stability analysis. There will be three drainage structures through this levee segment and a road ramp south of the railroad. Gabion protection would be required along the levee floodside.

b. Second Levee Segment

The second levee segment would start from the northeast abutment of the PR Hwy 52 bridge over Rio Nigua and tie into PR Hwy 52, between the intersections of PR Hwy 154 and PR Hwy 1 with PR Hwy 52. Total length of this levee segment is about 610 meters. This levee segment would protect the town of Salinas from flood waters entering the opening at the crossing of PR Hwy 1 and PR Hwy 52. The levee side slopes would be 1 vertical and 2.5 horizontal with a minimum crest width of three meters. Side slopes of the proposed levee segment were based on existing soil conditions, type of material used in construction, and stability analysis. A road ramp would be required where the levee segment crosses PR Hwy 1. Gabion protection would be required along the levee floodside.

c. Third Levee Segment

The third levee segment would protect the community of Coco. This levee segment would start at the southwest end of the community of Coco and tie into high grounds northeast of the community. Total length of this levee segment is about 3,981 meters. The levee side slopes would be 1 vertical and 2.5 horizontal with a minimum crest width of three meters. Side slopes of the proposed levee segment were based on existing soil conditions, type of material used in construction, and stability analysis. This levee segment would be adequately protected with established and well maintained grass over the earthen levee.

3. Bridges

Two bridges within the study area would be impacted. The railroad bridge located south of the town of Salinas would be removed and the PR Hwy 1 bridge would be replaced. A ford located between PR Hwy 1 and PR Hwy 52 in Rio Nigua would be removed. The PR Hwy 52 bridge and PR Hwy 154 bridge would not be replaced. Hydraulic design data for the PR Hwy 1 bridge is indicated in Table A-10.

4. Access Road

An unpaved access road would be provided as part of the recommended plan. It would start from the west bank of Rio Nigua at PR Hwy 1, continue north along the western right-of-way of the river channel and cross the Quebrada Honda to tie into an existing road. A ford would be required at Quebrada Honda and it would consist of only an unpaved road crossing.

5. Drainage Structures

There will be a total of three drainage structures as part of the recommended plan. The drainage structures consist of corrugated metal pipes with flap gates on the levee floodside to prevent backflow into the protected area.

6. Channel Realignment

To avoid relocating existing homes, parts of the proposed levee segment, between the coastline and PR Hwy 52, would be located in the existing channel. These locations are at the intersection of the railroad and Rio Nigua and upstream of the PR Hwy 1 bridge. The river channel would only be realigned at these locations to restore existing conveyance capacity.

7. Borrow and Disposal Areas

The location of the borrow and disposal areas are indicated in the Geotechnical Appendix. These locations would not impact the with project conditions flooded area.

C. Interior Flood Hydrology

The project levee system protects the town of Salinas from floods from Rio Nigua. Culverts are provided for interior drainage. The US Army Corps of Engineers, Hydrologic Engineering Center, Interior Hydrology Package, HEC-IFH computer program was used for the analysis. This program can simulate rainfall-runoff processes, stream flow routings, auxiliary inflows, diversions, ponding areas, gravity outlets, and pumping facilities.

D. Sediment Assessment

1. Sediment Model

As an aid in analyzing and computing the erosion and deposition for existing and with project conditions for Rio Nigua, sediment models were developed using the Hydrologic Engineering Center's computer program entitled "HEC-6 Scour and Deposition in Rivers and Reservoirs". The HEC-6 program uses storm hydrographs, geometric data, and field samples of bed material to analyze the sediment transport capacity of the floodway. The SAM program developed by the Waterways Experiment Station (WES) was also used.

2. Existing Conditions

a. Ground Cover

Tropical and farm vegetation covers the floodplain of the study area. This reduces the potential sediment runoff into the main channel. The majority of the floodplain appears to be stable except within the main channel, where there is little vegetation, relative to the rest of the floodplain.

b. Bed Samples

Three sediment samples were taken along Rio Nigua, one at the mouth of the river, one at PR Hwy 1 and one at PR Hwy 52. Gradation curves were generated from a sieve analysis performed on these samples, which revealed that the d_{50} grain size varied from very fine to medium gravel. There was some fine to medium sand at the d_{10} grain size, but no cohesive or silty soil were discovered.

c. Deposition and Erosion

Sediment deposition and erosion rates were calculated by deriving sediment rating curves from the gradation curves using the *Toffaleti-Meyer-Peter-Mueller* method from the Hydraulic Design Package for Channels (SAM) program. The amount of sediment transported along the effective channel area and within the channel cross sections were calculated through the HEC-6 Scour and Deposition in River and Reservoirs program within the effective channel flow area for the short term reliability and the long term maintenance.

3. Development of Sediment Models

a. 10-Year Event

The short term reliability of the 10-year storm event through the river revealed that there was a trap efficiency of 82 percent. In general, the river was in a state of minor erosion except near the railroad bridge, where the river degraded approximately .23 meters of sediment. There were some deposition south of the ford, near the confluence with Quebrada Honda. However, most of the aggradation occurred at the mouth of Rio Nigua, which was about .47 meters. The 10-year hydrograph was incorporated into the HEC-6 model for a duration of approximately .88 days.

b. SPF Event

The short term reliability of the SPF storm event through the river revealed that there was a trap efficiency of 72 percent. The river was in a general state of erosion, which varied from approximately .1 to .46 meters. The worst case of degradation was .81 meters, which occurred near the railroad bridge. There were some instances of deposition between the confluence of Quebrada Honda and the ford. The amount of aggradation between these two areas varied from approximately .05 to .54 meters. However, most aggradation occurred at the mouth of Rio Nigua, which reached up to 1.57 meters. The SPF hydrograph was incorporated into the HEC-6 model for a duration of approximately 1.21 days.

c. Long Term Maintenance

The long term maintenance of the river was determined by modeling a flow duration curve for approximately 219 days. This flow duration curve included the flows from 2.76 cms up to the 10-year flow. The trap efficiency of this model was 86 percent. The river was in a general state of deposition, which averaged approximately .19 to 1.14 meters from cross section 6 to cross section 13. The most aggregation was approximately 1.47 meters, which occurred at the outfall of the river. Most of the erosion occurred near cross section 2.5.

4. Conclusions

The well established vegetation on the overbanks will minimize any effects of erosions and deposition outside of the effective channel flow area. Large flood events quickly leave the main channel and traverse areas covered by vegetation. Overbank water velocities range from .05 meters per second to 1.17 meters per second which would be considered non-erosive under those conditions. This will translate into the majority of aggradation and degradation occurring within the river channel. The difference between the existing conditions and the proposed levee alignment will not appreciably change the channel deposition and erosion rates. This is due to the maintenance of the same flow regimes between the with-project and without-project design features.

5. Recommendations

There should be several base ranges located within the river between PR Hwy 52 and the outfall of the river. These base ranges should be established prior to having the proposed project in place. After the project is in place, surveys along this range would be taken after significant flood events and compared to the established base range surveys. Appropriate action would be taken by the local sponsor where signs of aggradation/degradation in the floodway have taken place. Gravel mining can be used as one means of regulating the deposition and erosion behavior of the floodway.

V. HYDRAULIC DESIGNS

A. Hydraulic Design Criteria

Hydraulic design criteria and procedures used herein are in accordance with standard engineering practice and applicable provisions of Corps Engineering Manuals and the Waterways Experimental Station "Hydraulic Design Criteria" relative to design and construction of Civil Works Projects. Engineering criteria adopted to meet special local conditions are in accordance with that previously approved for similar projects.

B. Levees

1. Alignment

A levee system designed to protect the town of Salinas and the community of Coco is shown on Plates A-2 and A-3. The existing condition HEC-2 model was modified to represent the with-project conditions by terminating cross sections at stations which would cross the levee alignment.

2. Levee Crest Elevation

Levee crest elevations were selected to conform to criteria and guidance shown in EC 1105-2-205, "Risk and Uncertainty". Water surface profiles for the SPF event and other design storms were compiled by superimposing design discharges on calibrated HEC-2 backwater computer models of the existing conditions for the Rio Nigua at Salinas floodway. The levee crest profile was established by determining the discharge that would provide the levee crest elevations from the risk analysis at the index locations. The discharge that reproduces the crest elevation at the index locations was determined to be 120% of the SPF. Preliminary cost of levees for various frequency discharges, data on maximum and minimum possible deviations in surface roughness values, various frequency flood profiles and discharges and levee cost were incorporated into the risk analysis. Hydraulic design data for the selected levee is indicated on Table A-8.

3. Levee Overtopping Analysis

The levee segments were evaluated and only one overtopping section was identified. The overtopping analysis was performed on Rio Nigua according to ETL 1110-2-299 dated 22 August 1986. The overtopping section would be provided between levee station 3+00 to 4+00 of the first levee segment. This location was identified as where there would be the least amount of damage if levee overtopping occurred. Superiority was provided to insure overtopping at the proposed site. This section would have one foot less of superiority than the remainder of the levee segment. Overtopping water surface profiles were computed by considering the uncertainties in "n" values, bridge openings and discharge hydrographs.

C. Drainage Structures

There will be a total of three drainage structures as part of the recommended plan. The culverts would be equipped with a flap gate on the levee flood side to prevent backflow into the protected area. Location of the drainage structures are indicated on Plates A-3 and A-4. Hydraulic design data for the culverts are indicated in Table A-9. The following describes each drainage structure.

1. Drainage Structure North of Railroad

The drainage structure north of the railroad consist of one - 1.52 meter diameter corrugated metal pipe. The invert of the culvert would be set at elevation 4.2 meters, NGVD and have an approximate length of 40 meters.

2. Drainage Structure North of PR Hwy 1

The drainage structure north of PR Hwy 1 consist of two - 1.52 meter diameter corrugated metal pipe. The invert of the culverts would be set at elevation 6.3 meters, NGVD and have an approximate length of 40 meters.

3. Drainage Structure South of PR Hwy 52

This drainage structure is located about 788 meters south of PR Hwy 52 along the proposed levee alignment. It consist of one - 1.52 meter diameter corrugated metal pipe. The invert of the culvert would be set at elevation 4.8 meters, NGVD and have an approximate length of 60 meters.

D. Channels

The existing Rio Nigua does not provide in-bank conveyance for discharges greater than the 1 in 2 year flow. Less frequent flood flows exceed the banks and are conveyed overland to the coast as sheet flow.

All interior drainage channels were designed to provide collection and conveyance of flow to the drainage structures, which would discharge to the flood plain. The channels would have minimal flood control value and are to provide continuous positive drainage to the drainage structures.

To avoid relocating existing homes parts of the proposed levee segment, between the coastline and PR Hwy 52, would be located in the existing channel. These locations are at the intersection of the railroad and Rio Nigua and upstream of the new PR Hwy 1 bridge. Conveyance lost by filling in the existing channel with the proposed levee would be replaced by providing a new realigned channel with similar in-bank conveyance characteristics.

E. Project Performance

1. Risk Analysis

A sensitivity analysis of the water surface profile for the 100-year flood was computed by using the HEC-2 existing conditions model. By varying the Manning's "n" value, upper and lower water surface profile were computed. The sensitivity analysis was conducted by carefully choosing a upper and lower model "n" value so as to result in a reasonable estimate of the stage uncertainty range. The stage difference between the upper and lower limits were taken to be the "reasonable" bounds, that is 95 percent of the stage uncertainty range. For each reach, a standard deviation was computed by dividing the difference between the upper and lower limits of the water surface profiles by four.

A mean standard deviation and a skew were determined from the discharge frequency curve and this was assumed the same for the whole basin.

2. Risk Analysis of Discharge Frequency

Hydrologic models, such as HEC-1, determine discharge-frequency by analyzing the rainfall runoff process and do not have known statistics. Accordingly synthetic statistics had to be produced in order to perform a risk analysis in this study. A straight line representing zero skew was passed through the HEC-1 results. Using discharges obtained from this line for the .01, .1, and .5 frequencies a synthetic mean of 3.898 and a standard deviation of 0.406 was determined in accordance with the procedures presented in EC 1105-2-205. An equivalent period of record of 25 years was established from a review of the hydrologic methodology.

3. Overtopping Analysis

The proposed levee segments will exclude flows up to and including the SPF event. Overtopping would be initiated in the planned overtopping area, which is located between levee station 3+00 and 4+00 of the first levee segment. This location was selected to provide control of initial overtopping and minimize the possibility of overtopping in areas which posed greater threat to loss of life and property.

The third levee segment, proposed for the community of Coco, does not tie into high ground at the downstream end. The downstream end terminates at a point where the design stage would no longer produce damages to local properties. Plate A-6 in the Hydrology and Hydraulics Appendix shows the flooded areas behind the proposed levee for the 10-year and SPF event. The existing ground slope would minimize stage increase behind the levee. The flooded area on the protected side of the levee is only up to levee station 1+80.

Hydrographs of flood events in Puerto Rico have a brief overall time frame. For the Coco location the time to peak from non-threatening flows to design flood discharges are often less than six hours. Total flood hydrographs usually last less than nine hours. Brief times to peak of storms in this area limit the effectiveness of any overtopping section as a flood warning mechanism. A project levee section designated for overtopping is not considered necessary to provide adequate warning.

Events which exceed the SPF discharge would cause additional flow around the downstream end of the levee and back toward the community. However, steep ground slopes would limit the actual flooded area.

4. Residual Flooding

With project in place, water surface elevations within the floodway are expected to be higher when compared to existing conditions. However, water surface elevation, within the protected areas, will be lower or would not cause damages when compared to existing conditions. Table A-7 and Plates A-8 through A-11 indicates a comparison of the water surface profiles, with and without project in place.

5. People at Risk

Residences and businesses of the town of Salinas and the communities of Playa de Salinas and Coco have been encroached into the fringe areas of the Rio Nigua flood plain. The upper reaches of the basin, that drain the mountain slopes, are steep and drain very quickly. Events are of a "flash flood" nature with little warning available. This type of flooding is typical for the basins in Puerto Rico. Flooding along the fringe areas occurs when flood stages exceed the banks of the existing channel. Flooding is quick and has a very short duration. Overbank velocities are low "filling" velocities for the more frequent events. Escape routes consist of paved roads which lead to higher grounds.

a. First and Second Levee Segments

The first and second levee segments would protect the town of Salinas and community of Playa de Salinas. Without project conditions, flooding in this area would first impact homes and businesses located on the east bank of Rio Nigua. For the town of Salinas the average depth and velocity of an SPF flood event would be about 2.2 meters and .59 meters per second, respectively. For the community of Playa de Salinas the average depth and velocity of an SPF flood event would be about .7 meters and .40 meters per second, respectively.

b. Third Levee Segment

The third levee segment would protect the community of Coco. Without project conditions, flooding in this area would first impact homes and businesses located on the east bank of Rio Nigua. For the community of Coco the average depth and velocity of an SPF flood event would be about 2.7 meters and .52 meters per second, respectively.

6. Data Collection

Joint field inspections with personnel from the US Army Corps of Engineers and the local sponsor would be required. Inspection teams would consist of personnel from appropriate engineering disciplines who would evaluate the performance of project features. Features such as channel and levee armoring would also be inspected to insure performance. Subsequent to the inspection a report is prepared to document any problems discovered by the inspection team and propose remedial work.

From the Hydrology and Hydraulics Appendix, Sediment Assessment, subsection D, paragraph 5, page A-15 recommends establishing base survey ranges prior to having the proposed project in place. After the proposed project is completed and a significant flood event has occurred in the floodway surveys along the established ranges would be taken and compared to pre-project conditions. Appropriate action would be taken by the local sponsor where signs of aggradation or degradation in the floodway have taken place. Gravel mining can be used as one means of regulating the deposition and erosion behavior in the floodway.

The above actions are taken in response to requirements in ER 1110-2-1405. Collection of data such as rainfall and high water marks after significant flood events would be compiled by the USGS and/or FEMA agencies.

RIO NIGUA SUBBASIN SOILS AND RUNOFF CURVE NUMBERS

SUBBASIN	PREDOMINANT SOIL TYPE	HYDROLOGIC SOIL GROUP	CURVE NUMBER AMC I	II	III
1	*DESCALABRADO-GUAYAMA ASSOCIATION*	D	68	84	93
2	*DESCALABRADO-GUAYAMA ASSOCIATION*	D	68	84	93
3	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
4	*DESCALABRADO-GUAYAMA ASSOCIATION*	D	68	84	93
5	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
6	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
7	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
8	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
9	*COAMO-GUAMANI-VIVES ASSOCIATION*	B	58	76	89
10	*JACANA-AMELIA-FRATERNIDAD ASSOCIATION*	D	70	85	94

TABLE A-1

STREAM GAGES IN THE NIGUA-LAPA-MAJADA BASIN

STATION NUMBER	STATION NAME	DRAINAGE AREA	PERIOD OF RECORD	REMARKS
50 1007 00	Rio Majada at Rabo del Buey	57.06 sq km	1960 - 1962 1965 - 1970	The record is not continuous The gage is no longer in service
50 1012 00	Rio Majada at Sabana Llana	89.36 sq km	1965 - 1971	The record is not continuous The gage is no longer in service
50 1002 00	Rio Lapa near Rabo del Buey	25.69 sq km	1953 - 1963 1988 - 1991	The record for 1953 - 1963 is for annual low-flow measurements only
50 1004 50	Rio Majada at La Plena	43.25 sq km	1988 - 1991	The record is characterized as fair

NGAGE2.WK1 TABLE A-2

AVERAGE POINT RAINFALL
RIO NIGUA BASIN

DURATION	EXCEEDANCE IN PERCENT 50	20	10	4	2	1	SPF
15 min.	2.97	3.69	4.72	5.18	5.94	6.71	8.38
1 hr.	5.38	6.99	7.95	9.42	10.72	11.99	14.99
2 hr.	6.65	8.46	10.16	11.99	13.34	14.76	18.44
3 hr.	6.99	9.53	11.20	13.34	14.50	16.79	20.98
6 hr.	8.46	11.71	13.74	16.54	19.02	21.21	26.52
12 hr.	10.11	13.84	16.64	19.43	22.23	25.02	31.27
24 hr.	11.71	16.54	19.69	23.66	26.54	30.10	37.62

Rainfall is in centimeters

TABLE A-3

RIO NIGUA SUBBASIN CHARACTERISTICS

SUBBASIN	AREA	LENGTH	[illegible]	[illegible]	[illegible]	SLOPE	LAG
1	57.055 sq km	18587.4 m	8705.2 m	850.0 m	80.0 m	.041425	1.2787
2	32.088 sq km	11659.9 m	5610.3 m	760.0 m	70.0 m	.059178	0.7786
3	4.302 sq km	4099.2 m	2728.0 m	300.0 m	50.0 m	.060987	0.3003
4	14.561 sq km	6913.3 m	4244.6 m	610.0 m	50.0 m	.081005	0.4357
5	1.792 sq km	4103.4 m	2669.6 m	220.0 m	45.0 m	.042651	0.3092
6	4.198 sq km	4482.8 m	2172.9 m	130.0 m	25.0 m	.023424	0.5171
7	9.891 sq km	10454.9 m	6037.1 m	410.0 m	8.0 m	.038451	0.8290
8	1.831 sq km	6700.0 m	3029.8 m	53.0 m	10.0 m	.006419	1.1104
9	10.844 sq km	7367.6 m	3782.8 m	360.0 m	8.0 m	.047778	0.5592
10	5.265 sq km	6615.6 m	3589.9 m	230.0 m	0.0 m	.034767	0.6101

Lag in hours

NACRE2.WK1

TABLE A-4

EXISTING CONDITIONS ROUTED PEAK DISCHARGES

FREQUENCY OF EVENT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LOCATION				Peaks are cms			
At the mouth of Rio Nigua	224	527	748	1,390	1,591	1,967	2,475
Below confluence with Quebrada Honda	231	540	768	1,420	1,623	2,010	2,528
Above confluence with Quebrada Honda	226	526	749	1,384	1,575	1,953	2,458
Above Puerto Rico Highway 52	219	508	722	1,331	1,511	1,865	2,346
Above a point near southern Coco	228	526	746	1,369	1,556	1,912	2,404
Above confluence with the subbasin 5 tributary	231	527	750	1,361	1,545	1,887	2,372
Rio Majada above the confluence with Rio Nigua	215	492	697	1,270	1,453	1,784	2,243

PEAKCMS.WK1

TABLE A-5

[illegible]

COMPARISON OF DISCHARGE FREQUENCIES

Peaks are cms

	[illegible]	[illegible]	[illegible]	[illegible]	100-YEAR
REGIONAL EQUATIONS	124	419	653	872	1,130
LOG-PEARSON GAGE DATA (N=9)	169	326	416	487	561
HEC-1 MODEL ANALYSIS	131	423	767	877	1,074

NGB1007.WK1

TABLE A-6

TABLE A-7
RIO NIGUA AT SALINAS WATER SURFACE ELEVATIONS
EXISTING AND WITH-PROJECT CONDITIONS

Cross Section	Existing Conditions	With Project	Existing Conditions	With Project	Existing Conditions	With Project	Existing Conditions	With Project	Existing Conditions	With Project	Existing Conditions	With Project	Existing Conditions	With Project
	<--- 2-YR --->		<--- 5-YR --->		<--- 10-YR --->		<--- 25-YR -->		<--- 50-YR --->		<--- 100-YR -->		<----- SPF --->	
0.1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1.0	0.5	0.5	0.8	0.8	1.1	1.1	1.4	1.5	1.5	1.6	1.6	1.8	1.7	2.0
2.0	1.5	1.6	2.1	2.2	2.4	2.4	2.8	2.9	3.0	3.0	3.2	3.2	3.4	3.4
2.5	1.9	1.9	2.5	2.5	2.7	2.7	3.2	3.2	3.3	3.3	3.5	3.4	3.6	3.7
3.0	3.1	2.8	3.5	3.5	3.7	3.7	4.1	4.1	4.3	4.2	4.4	4.4	4.6	4.6
4.0	4.5	4.5	5.1	5.1	5.5	5.4	6.1	6.1	6.2	6.3	6.5	6.6	6.8	7.0
5.0	4.5	4.5	5.2	5.1	5.5	5.5	6.2	6.2	6.3	6.3	6.6	6.7	6.9	7.0
6.0	5.2	5.2	6.0	5.9	6.4	6.3	7.2	7.1	7.4	7.3	7.7	7.7	8.0	8.1
7.0	5.9	5.7	6.6	6.5	7.0	6.9	7.8	7.7	8.0	7.9	8.3	8.3	8.7	8.8
8.0	6.0	5.8	6.7	6.5	7.1	6.9	7.9	7.8	8.1	8.0	8.4	8.4	8.8	8.8
9.0	7.7	7.1	8.4	8.1	8.7	8.5	9.4	9.4	9.6	9.6	9.9	10.0	10.2	10.4
10.0	8.5	8.6	9.5	9.7	10.0	10.3	10.9	11.3	11.2	11.6	11.5	12.0	12.0	12.5
11.0	8.8	8.8	10.0	10.2	10.5	10.9	11.7	12.2	12.0	12.5	12.4	13.1	12.9	13.8
12.0	9.5	9.6	11.0	11.2	11.7	12.1	12.9	13.7	13.1	14.1	13.5	14.8	14.0	15.5
13.0	11.1	11.1	12.5	12.6	13.0	13.3	14.0	14.7	14.2	15.1	14.5	15.6	14.9	16.3
14.0	12.2	12.2	13.5	13.6	14.1	14.3	15.4	15.8	15.7	16.1	16.1	16.7	16.5	17.3
15.0	12.2	12.2	13.6	13.6	14.2	14.3	15.4	15.8	15.7	16.2	16.2	16.9	15.9	17.0
16.0	13.4	13.4	14.7	14.7	15.4	15.5	16.9	17.1	17.3	17.5	17.9	18.2	18.5	18.7
17.0	14.8	14.8	15.8	15.8	16.4	16.4	17.6	17.6	18.2	18.2	18.6	18.6	19.1	19.1
18.0	17.4	17.4	18.7	18.7	19.4	19.4	20.8	20.8	20.8	20.8	21.2	21.2	21.7	21.7
19.0	18.6	18.6	19.3	19.3	19.7	19.7	20.9	20.9	21.1	21.1	21.5	21.6	22.2	22.2
19.1	19.6	19.6	20.3	20.3	20.5	20.5	21.1	21.1	21.3	21.3	21.7	21.8	22.4	22.4
20.0	20.9	20.9	21.6	21.6	21.9	22.0	22.7	22.7	22.9	22.9	23.1	23.2	23.6	23.6
21.0	22.1	22.1	23.1	23.1	23.5	23.6	24.7	24.7	24.9	24.9	25.3	25.4	25.7	25.8
21.8	27.8	27.8	28.7	28.8	29.2	29.3	30.2	30.3	30.4	30.5	30.7	30.9	31.2	31.4
22.0	27.8	27.9	28.8	28.8	29.3	29.3	30.2	30.3	30.4	30.6	30.8	30.9	31.2	31.4
23.0	36.3	36.2	36.8	36.9	37.2	37.3	37.8	37.9	37.9	38.1	38.2	38.3	38.4	38.7
24.0	42.9	43.0	43.7	43.7	44.0	44.0	44.8	44.9	45.0	45.1	45.4	45.5	45.8	46.0
24.5	44.5	44.5	45.2	45.2	45.6	45.5	46.4	46.3	46.6	46.6	47.0	46.9	47.5	47.4
25.0	46.7	46.7	47.4	47.5	47.8	47.8	48.5	48.6	48.6	48.7	48.9	49.0	49.3	49.4

NOTE: WATER SURFACE ELEVATIONS ARE IN METERS, NGVD

TABLE A-8
HYDRAULIC DESIGN DATA FOR THE SELECTED LEVEE
RECOMMENDED PLAN

CROSS SECTION	COMMENTS	EXISTING GR. ELEV. M-NGVD	RIVER INVERT M-NGVD	DESIGN WSEL M-NGVD	CREST ELEVATION M-NGVD	LEVEE HEIGHT M
.1	OCEAN		-1.0	0.7		
1.0		1.6	-0.5	2.0	4.5	2.9
2.0		3.0	-0.4	3.4	4.5	1.5
2.5		3.0	0.5	3.7	4.8	1.8
3.0		4.0	1.1	4.6	5.8	1.8
4.0	D/S RAILROAD	5.0	1.5	7.0	8.3	3.3
5.0	U/S RAILROAD	5.0	1.5	7.0	8.4	3.4
6.0		6.0	1.5	8.1	9.5	3.5
7.0	D/S P.R. HWY 1	7.0	1.8	8.8	10.2	3.2
8.0	U/S P.R. HWY 1	7.0	2.0	8.8	10.2	3.2
9.0		9.0	3.0	10.4	11.9	2.9
10.0		10.0	4.0	12.5	13.9	3.9
11.0		10.0	5.0	13.8	15.3	5.3
12.0		11.0	6.5	15.5	17.2	6.2
13.0		12.0	7.5	16.3	17.9	5.9
14.0	D/S P.R. HWY 52	18.8	8.0	17.3	18.8	0.0
15.0	U/S P.R. HWY 52	18.9	9.0	17.0	18.9	0.0
16.0		16.5	10.0	18.7	20.3	3.8
17.0	D/S P.R. HWY 154	20.4	13.0	19.1	20.4	0.0
19.0	U/S P.R. HWY 154					
19.1						
20.0		20.0	17.0	23.6	24.2	4.2
21.0		24.7	19.5	25.8	26.8	2.1
21.8		27.8	26.0	31.4	32.0	4.2
22.0		27.8	26.0	31.4	32.0	4.2
23.0		35.0	34.0	38.7	39.3	4.3
24.0		42.6	40.0	46.0	46.9	4.3
24.5		44.8	42.5	47.4	48.1	3.3
25.0		50.3	44.7	49.4	50.3	0.0

D/S = DOWNSTREAM
U/S = UPSTREAM
FROM CROSS SECTIONS 1 TO 14 IS THE LEVEE SEGMENT PROTECTING THE TOWN OF SALINAS AND THE COMMUNITY OF PLAYA DE SALINAS
FROM CROSS SECTIONS 15 TO 17 IS THE LEVEE SEGMENT NORTH OF P.R. HWY 52
FROM CROSS SECTIONS 20 TO 25 IS THE LEVEE SEGMENT PROTECTING THE COMMUNITY OF COCO

TABLE A-9
HYDRAULIC DESIGN DATA FOR INTERIOR DRAINAGE CULVERTS
RECOMMENDED PLAN

LOCATION	AVERAGE GROUND ELEV. (m) NGVD	LEVEE CROWN ELEV. (m) NGVD	CULVERT LENGTH (m)	CULVERT INVERT (m) NGVD	CULVERT NO.- DIA. (m)
NORTH OF RAILROAD	5.0	8.4	40	4.2	1-1.52
NORTH OF P.R. HWY 1	7.0	10.2	40	6.3	2-1.52
SOUTH OF P.R. HWY 52	10.0	13.9	60	4.8	1-1.52

NOTE: ALL CULVERTS WILL BE PROVIDED WITH A FLAPGATE

TABLE A-10
RESIDUAL FLOODING STAGES
RECOMMENDED PLAN

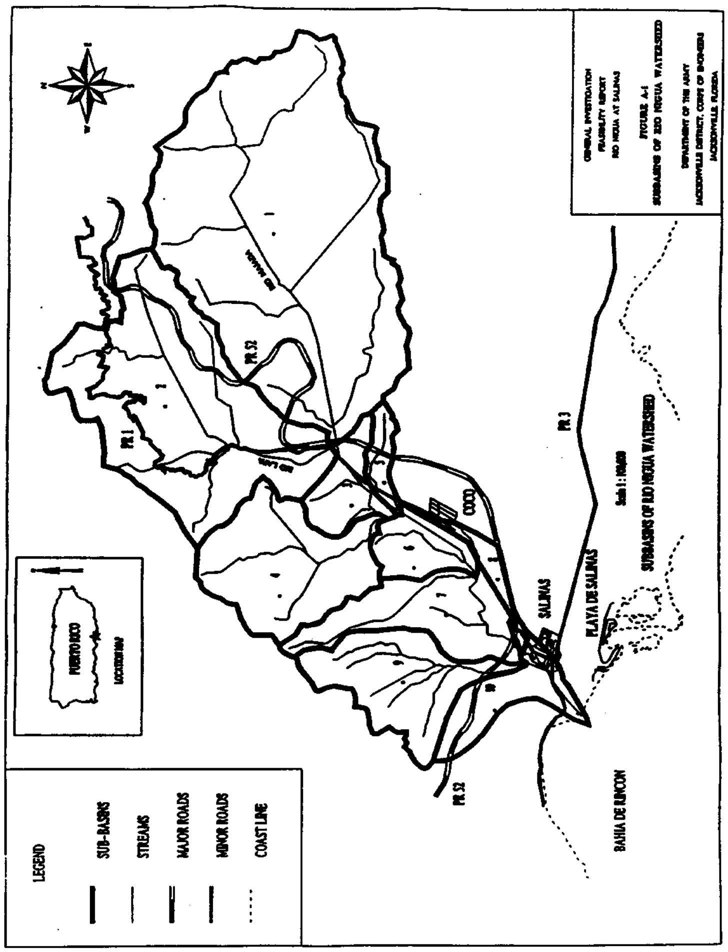
CULVERT LOCATION	10-YEAR EXISTING CONDITIONS FLOOD STAGE (M, NGVD)	10-YEAR WITH PROJECT PONDING STAGE (M, NGVD)
NORTH OF RAILROAD	6.4	5.6
NORTH OF P.R. HWY 1	8.7	7.3
SOUTH OF P.R. HWY 52	10.5	9.2

TABLE A-11
HYDRAULIC DESIGN DATA FOR P.R. HWY 1 BRIDGE
RECOMMENDED PLAN

BRIDGE LOCATION	DESIGN WSEL (M, NGVD)	MIN LOW CHORD ELEV (M, NGVD)	MII AREA REQ'D (SQ. M)	CHANNEL INVERT (M, NGVD)	CHANNEL BOTTOM WIDTH (M)	CHANNEL SIDE SLOPES (V:H)
SALINAS, P.R.	8.4	8.7	603	2.0	70	1:3

TABLE A-12
TIDE-FREQUENCY ELEVATIONS
RECOMMENDED PLAN

PERCENT CHANCE TIDE EVENTS	TIDE ELEVATIONS (M, NGVD)
0.2	2.90
1	2.19
4	1.34
10	0.68


LEGEND
SUB-BASINS
STREAMS
MAJOR ROADS
MINOR ROADS
COAST LINE
PUERTO RICO
LOCATION MAP
PR 52
PR 1
PR 3
COCO
SALINAS
PLAYA DE SALINAS
BAHIA DE RINCON
SUBBASINS OF RIO NIGUA WATERSHED
GENERAL INVESTIGATION
FEASIBILITY REPORT
RIO NIGUA AT SALINAS
FIGURE A-1
SUBBASINS OF RIO NIGUA WATERSHED
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

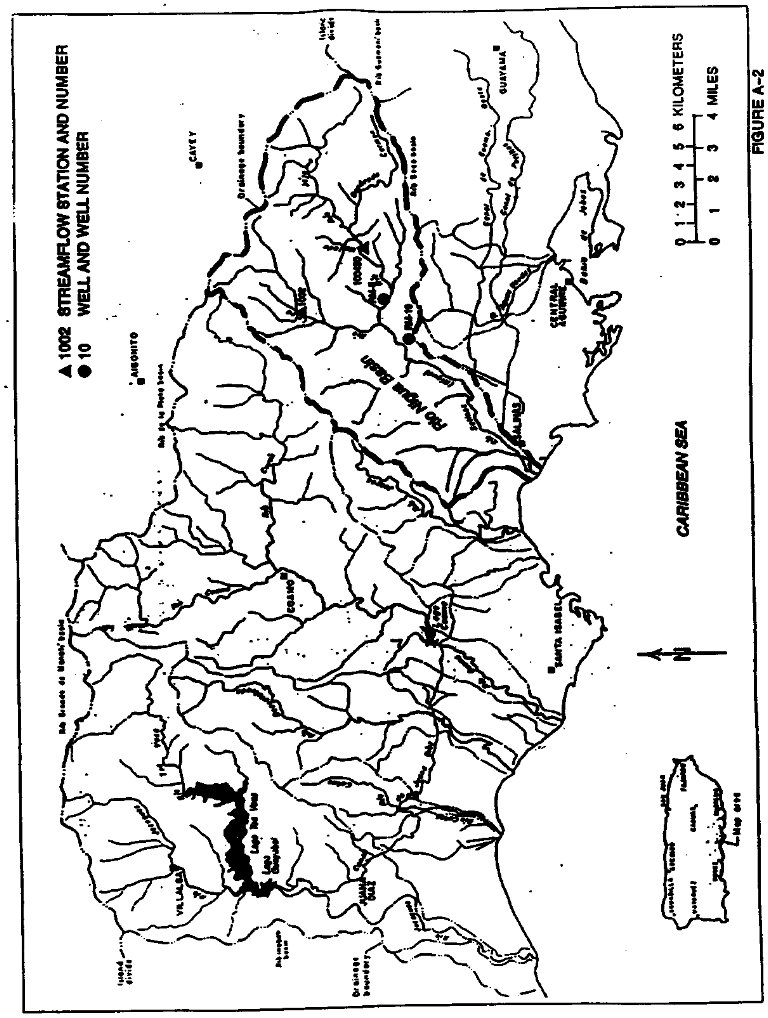
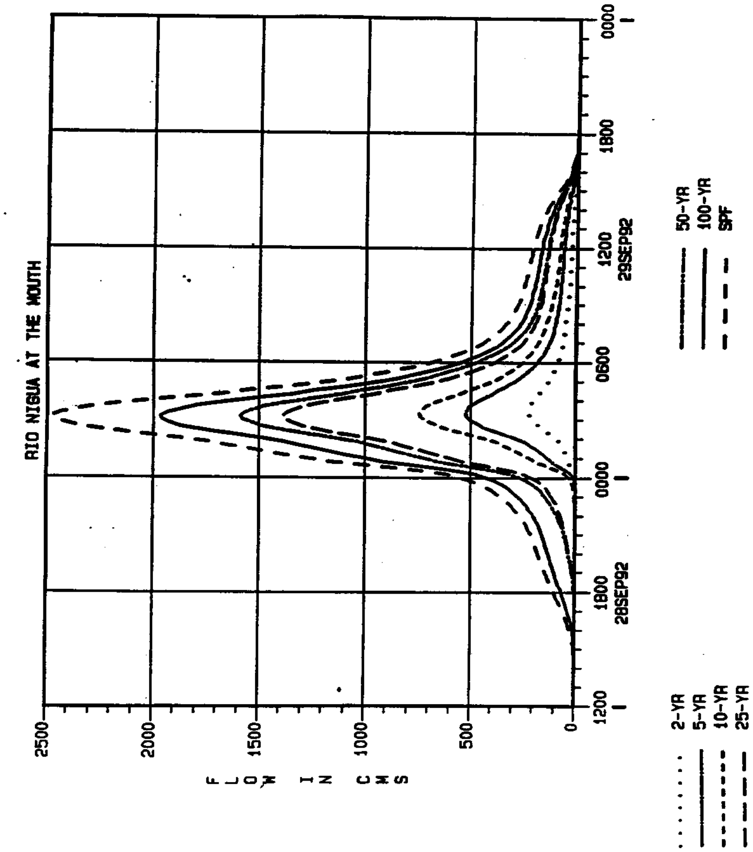

▲ 1002 STREAMFLOW STATION AND NUMBER
● 10 WELL AND WELL NUMBER
CARIBBEAN SEA
0 1 2 3 4 5 6 KILOMETERS
0 1 2 3 4 MILES
N

FIGURE A-2

FIGURE A-3


RIO NIGUA AT THE MOUTH
FLOW IN CMS
2500
2000
1500
1000
500
0
1200
1800
28SEP92
0000
0600
1200
29SEP92
1800
0000
2-YR
5-YR
10-YR
25-YR
50-YR
100-YR
SPF

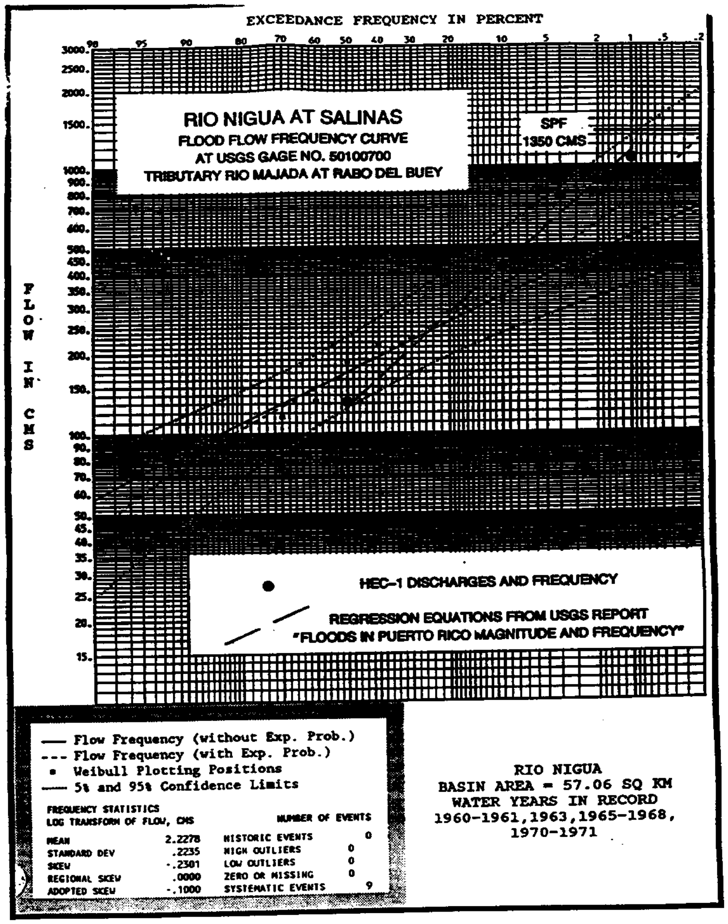
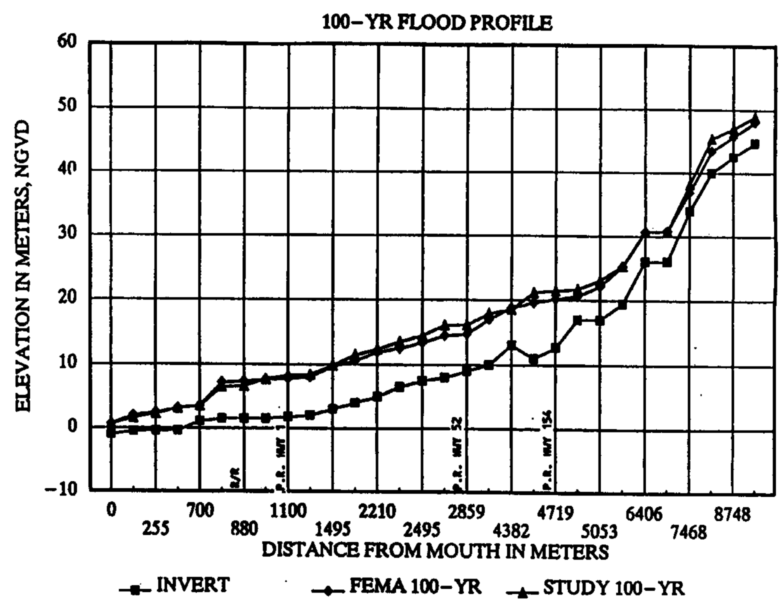

EXCEEDANCE FREQUENCY IN PERCENT
FLOW IN CMS
RIO NIGUA AT SALINAS
FLOOD FLOW FREQUENCY CURVE
AT USGS GAGE NO. 50100700
TRIBUTARY RIO MAJADA AT RABO DEL BUEY
SPF
1350 CMS
HEC-1 DISCHARGES AND FREQUENCY
REGRESSION EQUATIONS FROM USGS REPORT
"FLOODS IN PUERTO RICO MAGNITUDE AND FREQUENCY"
Flow Frequency (without Exp. Prob.)
Flow Frequency (with Exp. Prob.)
Weibull Plotting Positions
5% and 95% Confidence Limits
FREQUENCY STATISTICS
LOG TRANSFORM OF FLOW, CMS
MEAN 2.2278
STANDARD DEV .2235
SKEW -.2301
REGIONAL SKEW .0000
ADOPTED SKEW -.1000
NUMBER OF EVENTS
HISTORIC EVENTS 0
HIGH OUTLIERS 0
LOW OUTLIERS 0
ZERO OR MISSING 0
SYSTEMATIC EVENTS 9
RIO NIGUA
BASIN AREA = 57.06 SQ KM
WATER YEARS IN RECORD
1960-1961,1963,1965-1968,
1970-1971

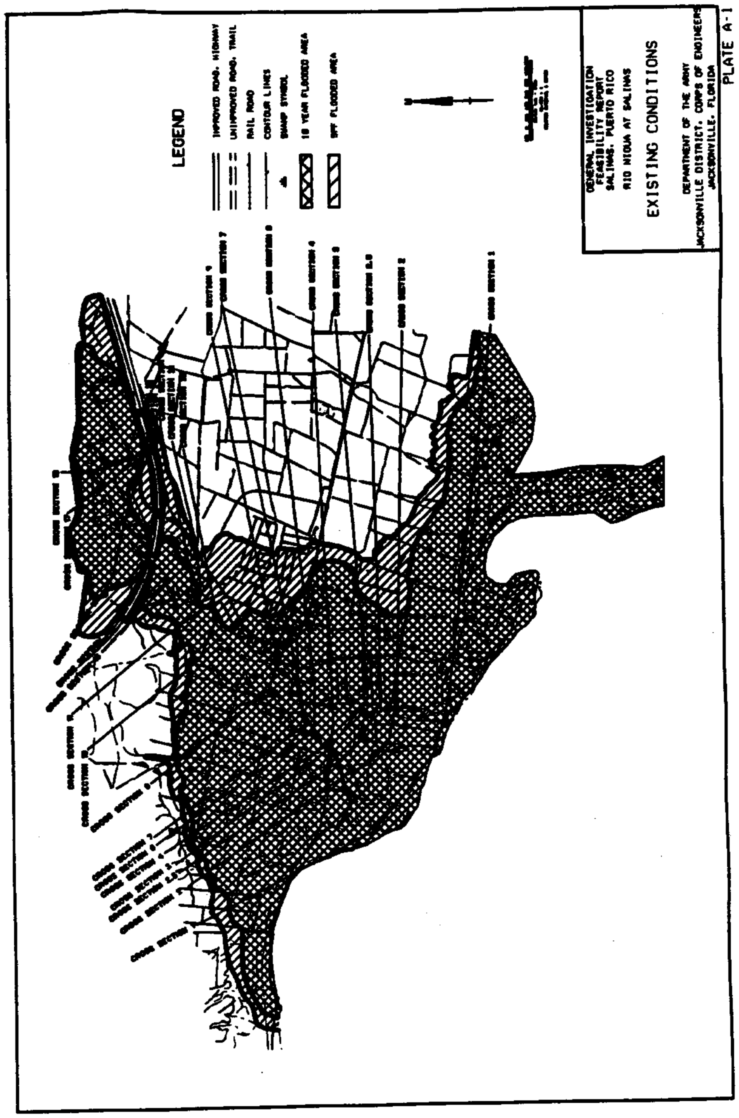
FIGURE A-4

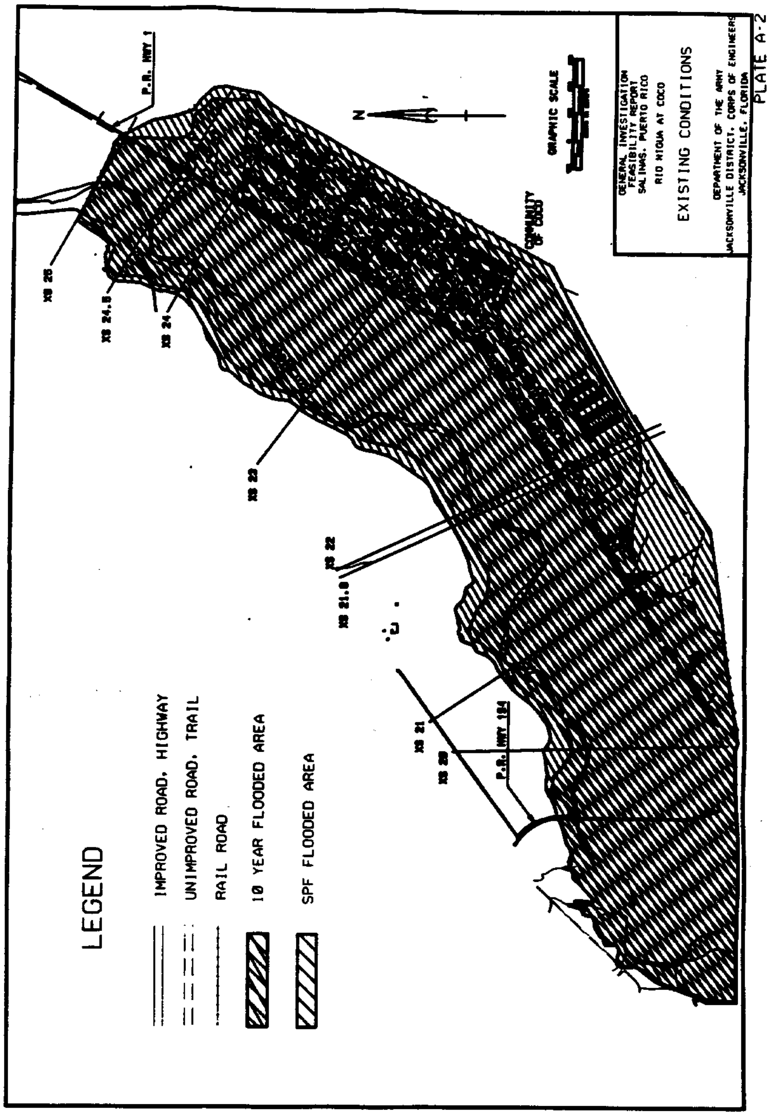


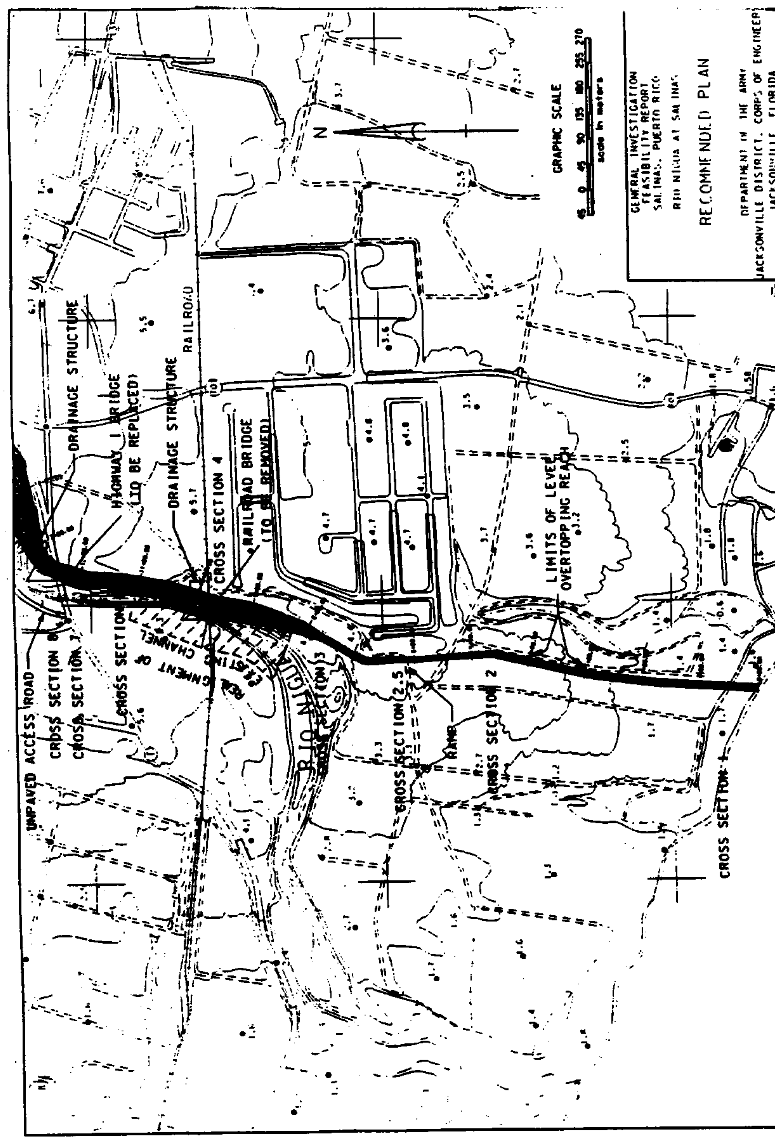
GENERAL INVESTIGATION
FEASIBILITY REPORT
RIO NIGUA AT SALINAS

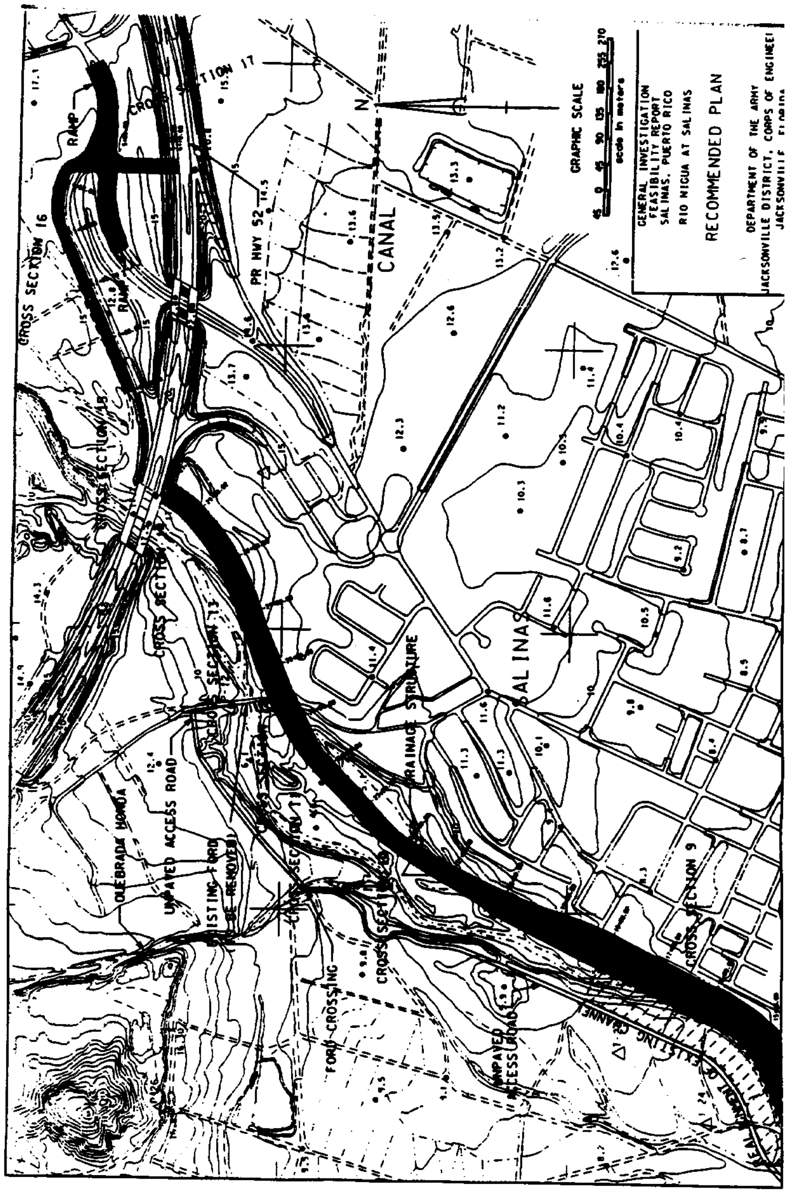
FIGURE A-5
COMPARISON OF 100-YR FLOOD PROFILE

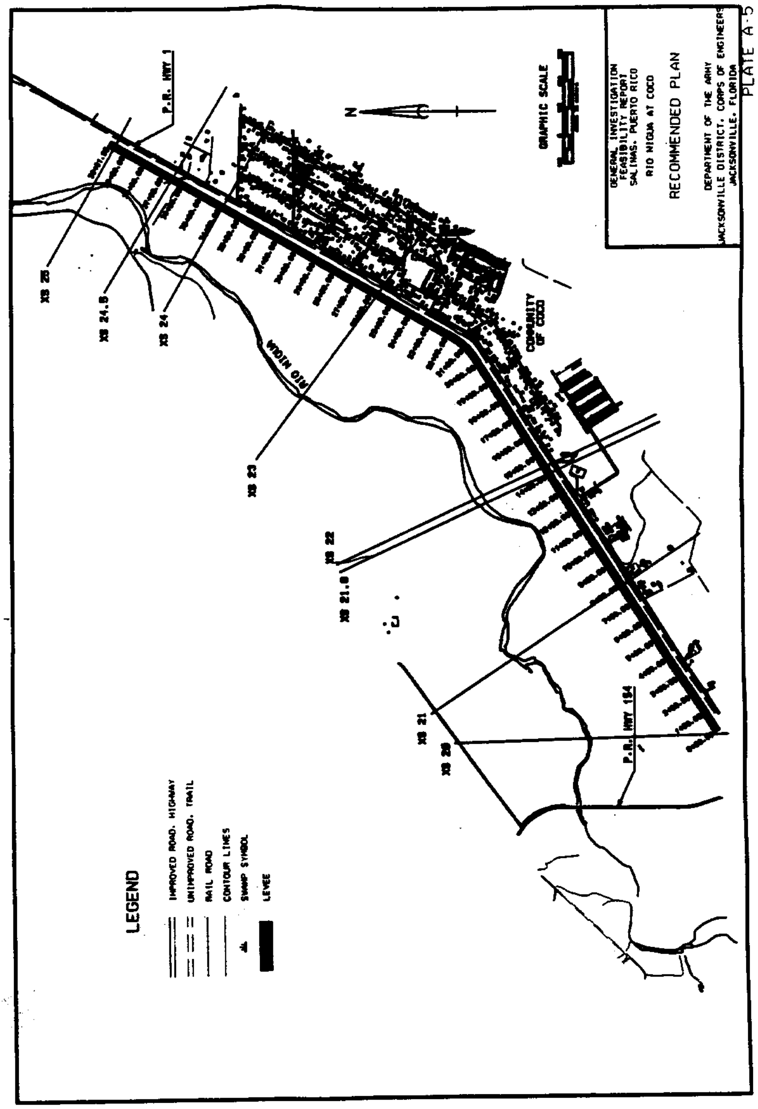
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

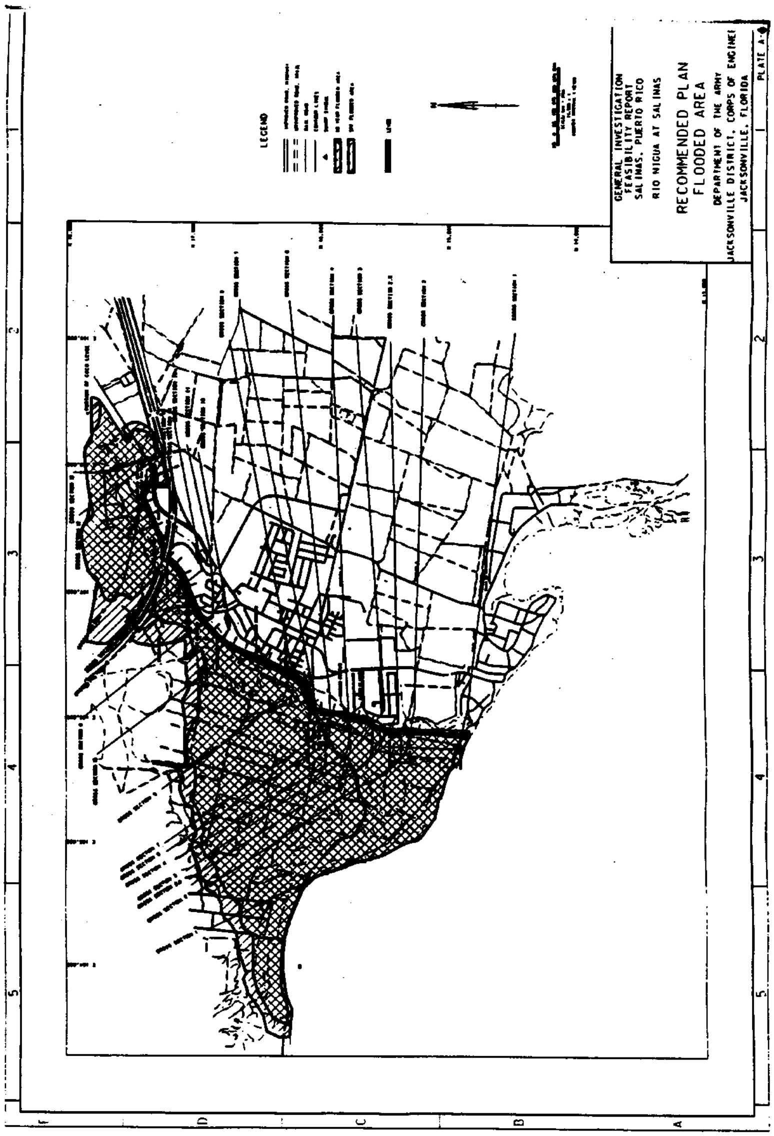

LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
CONTOUR LINES
SWAMP SYMBOL
10 YEAR FLOODED AREA
SPF FLOODED AREA
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
EXISTING CONDITIONS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE A-1

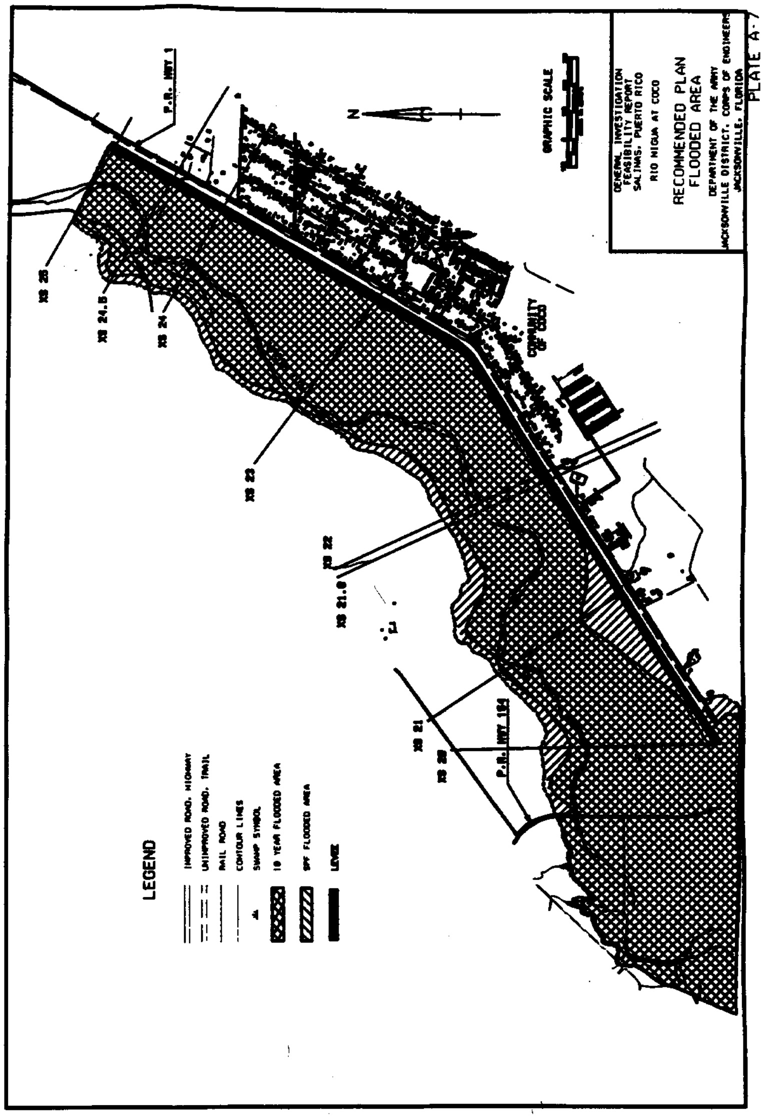

LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
10 YEAR FLOODED AREA
SPF FLOODED AREA
XS 25
XS 24.5
XS 24
XS 23
XS 22
XS 21.8
XS 21
XS 20
P.R. HWY 1
P.R. HWY 154
COMMUNITY OF COCO
N
GRAPHIC SCALE
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
EXISTING CONDITIONS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE A-2

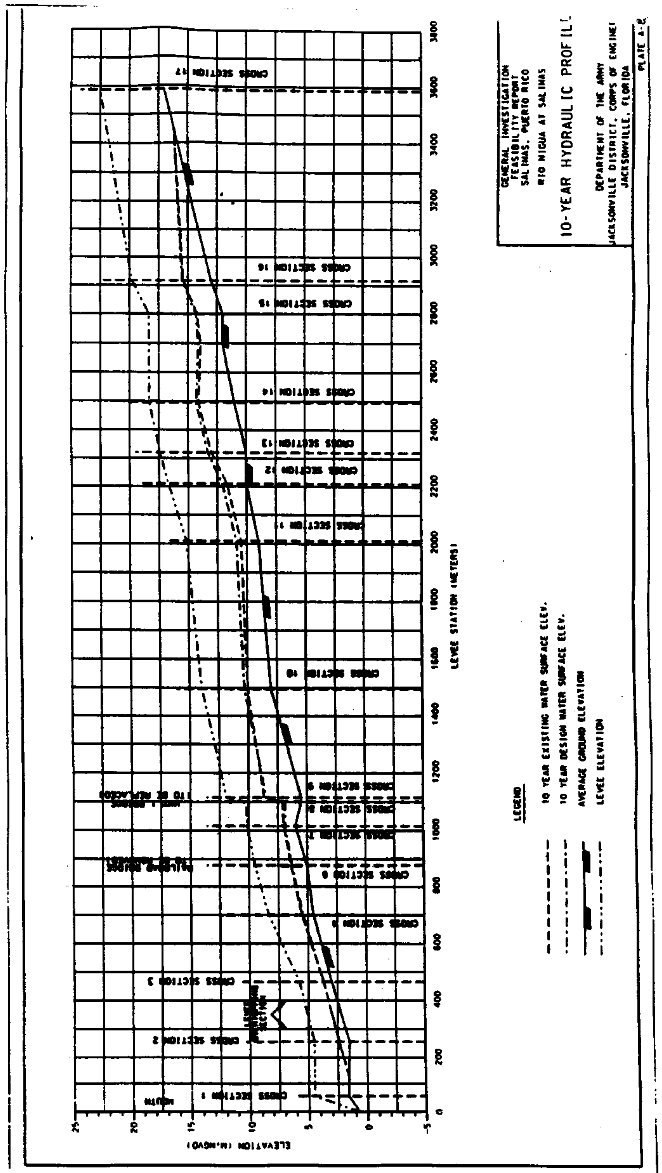

UNPAVED ACCESS ROAD
CROSS SECTION 8
CROSS SECTION 7
DRAINAGE STRUCTURE
HIGHWAY 1 BRIDGE (TO BE REPLACED)
DRAINAGE STRUCTURE
CROSS SECTION 4
RAILROAD BRIDGE (TO BE REMOVED)
RAILROAD
REALIGNMENT OF EXISTING CHANNEL
RIO NIGUA
CROSS SECTION 2.5
RAMP
CROSS SECTION 2
LIMITS OF LEVEE OVERTOPPING REACH
CROSS SECTION 1
N
GRAPHIC SCALE
scale in meters
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

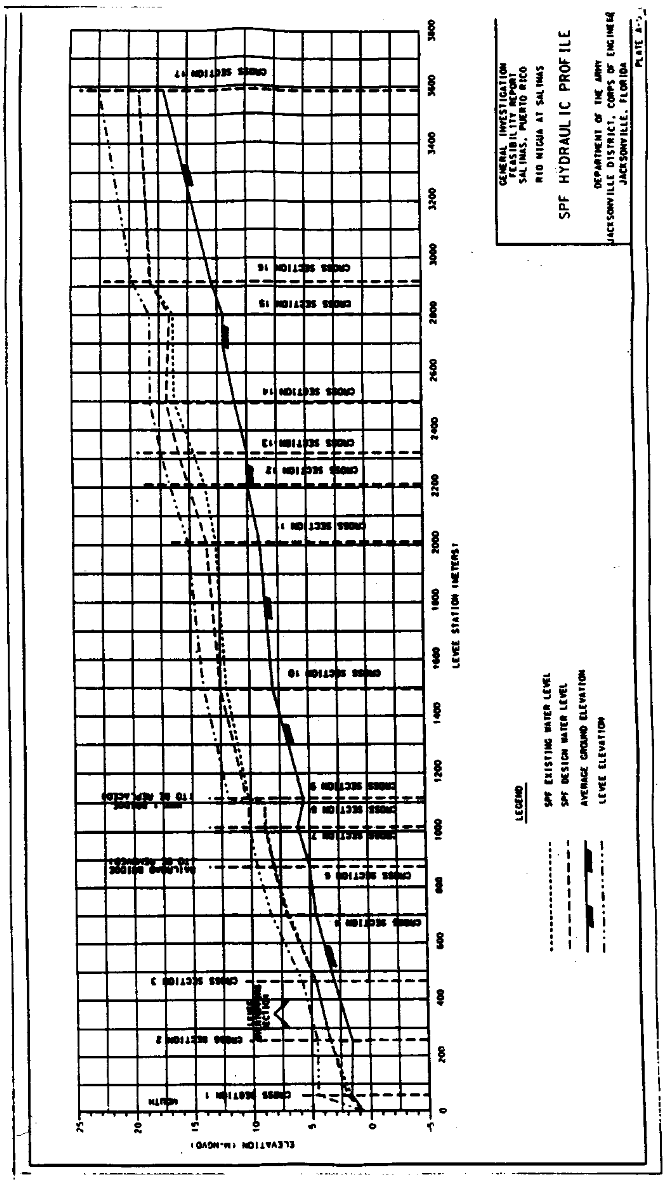

GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
GRAPHIC SCALE
SALINAS
CANAL
PR HWY 52
DRAINAGE STRUCTURE
QUEBRADA HONDA
UNPAVED ACCESS ROAD
FORD CROSSING
CROSS SECTION 16
CROSS SECTION 9
RAMP

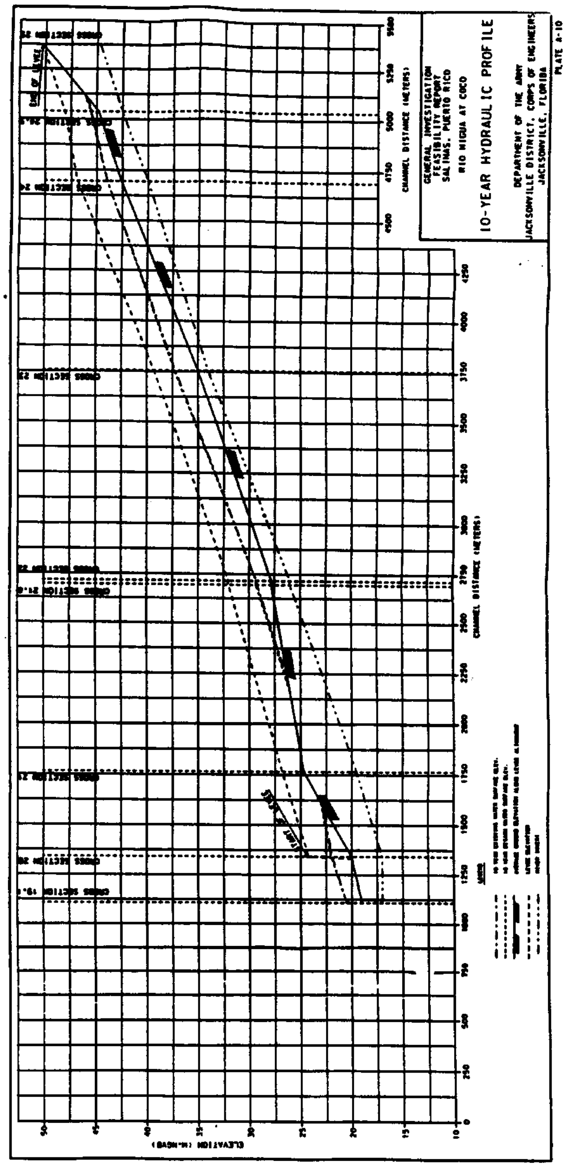

GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
RECOMMENDED PLAN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE A-5
GRAPHIC SCALE
N
P.R. HWY 1
P.R. HWY 154
RIO NIGUA
COMMUNITY OF COCO
XS 25
XS 24.5
XS 24
XS 23
XS 22
XS 21.8
XS 21
XS 20
LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
CONTOUR LINES
SWAMP SYMBOL
LEVEE

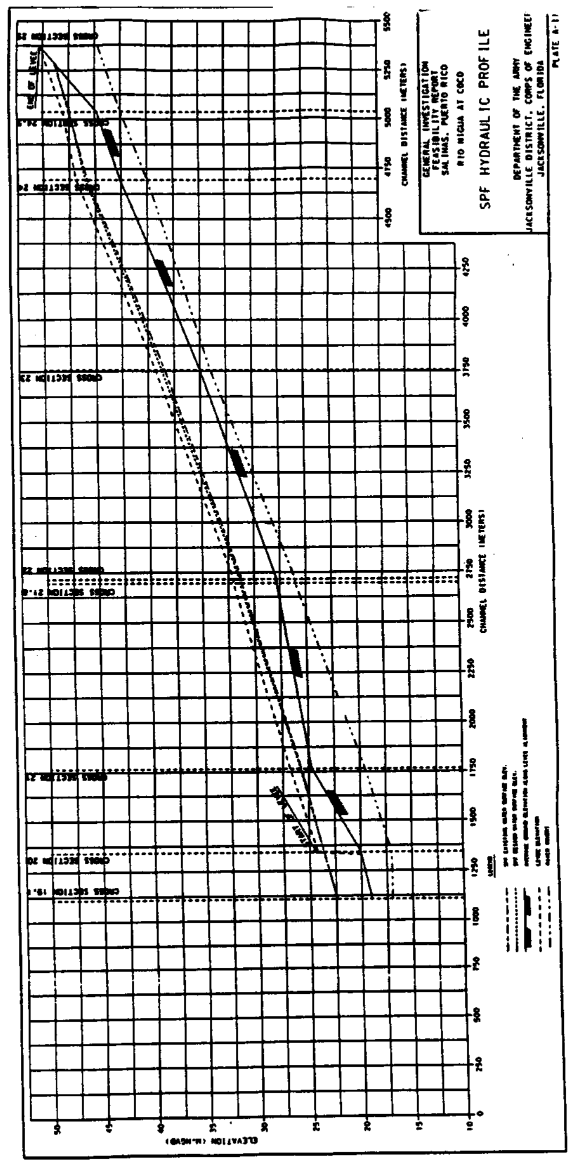

LEGEND
GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
RECOMMENDED PLAN
FLOODED AREA
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINE
JACKSONVILLE, FLORIDA
PLATE A-


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
RECOMMENDED PLAN
FLOODED AREA
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GRAPHIC SCALE
COMMUNITY OF COCO
P.R. HWY 1
P.R. HWY 154
XS 20
XS 21
XS 21.8
XS 22
XS 23
XS 24
XS 24.5
XS 25
LEGEND
IMPROVED ROAD, HIGHWAY
UNIMPROVED ROAD, TRAIL
RAIL ROAD
CONTOUR LINES
SWAMP SYMBOL
10 YEAR FLOODED AREA
SPF FLOODED AREA
LEVEE


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
10-YEAR HYDRAULIC
DEPARTMENT OF THE ARMY
JACKSONVILLE, FLORIDA
LEGEND
10 YEAR EXISTING WATER SURFACE ELEV.
10 YEAR DESIGN WATER SURFACE ELEV.
AVERAGE GROUND ELEVATION
LEVEE ELEVATION
LEVEE STATION (METERS)
ELEVATION (M.NGVD)


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
SPF HYDRAULIC PROFILE
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
LEGEND
SPF EXISTING WATER LEVEL
SPF DESIGN WATER LEVEL
AVERAGE GROUND ELEVATION
LEVEE ELEVATION
LEVEE STATION (METERS)
ELEVATION (M-NGVD)


GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
10-YEAR HYDRAULIC PROFILE
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE A-10
CHANNEL DISTANCE (METERS)
ELEVATION (M-NGVD)


SPF HYDRAULIC PROFILE
CHANNEL DISTANCE (METERS)
ELEVATION (M-NGVD)

RIO NIGUA AT SALINAS, PUERTO RICO

FEASIBILITY REPORT

APPENDIX B

GEOTECHNICAL

TABLE OF CONTENTS

List of Plates

GEOTECHNICAL

1. Introduction. This appendix presents the results of the subsurface investigations and subsequent geotechnical design and analysis for each major feature of the proposed flood control project at Salinas, Puerto Rico.

The Salinas Levee is east of the existing Nigua River and provides flood protection to the town of Salinas and the community of Playa de Salinas. The first segment of this levee begins at the coastline and extends north to the Puerto Rico Highway 52 bridge embankment. This segment of the levee is approximately 2.95 kilometers long and has an average embankment height ranging from 1.5 meters in the coastal area to 5.7 meters in the vicinity of Puerto Rico Highway 52. The existing Nigua River channel will be realigned to the west at several locations to accommodate the levee alignment. The channel depth will not be increased. There are three drainage structures along the levee. A new bridge at Puerto Rico Highway 1 will be required to span the Nigua River and the levee. The second segment of the Salinas Levee begins at the Puerto Rico Highway 52 embankment, extends northeast approximately 0.61 kilometers, intersects Puerto Rico Highway 1, and terminates at Puerto Rico Highway 52. This levee segment has an average embankment height of 3.3 meters.

The Coco Levee is north of the Salinas Levee, east of the Nigua River and protects the community of Coco from flood waters. The Coco Levee begins south of the community of Coco, follows to the west of Puerto Rico Highway 1, and ends at high ground north of the community. The levee is approximately 3.94 kilometers long and has an average height of 3.7 meters.

2. Salinas Levee and Channel Realignment.

a. Investigations Performed.

(1) Core Borings. Subsurface investigations were conducted along the proposed levee alignment in April 1994.

Sixteen core borings designated CB-SAL-1 through CB-SAL-16 were spaced at approximately 300 meters along the Salinas Levee alignment from station 0+00 at the coast to station 29+63 at the downstream side of Puerto Rico Highway 52. The core boring locations are shown on plates B-1 and B-2. No core borings were drilled along the levee alignment upstream of Puerto Rico Highway 52. This 0.73 kilometer segment of levee was added during the course of the Feasibility Study after field investigations were concluded.

The core borings were drilled to the anticipated depth of influence for levee stability and channel excavation and ranged in depth from 4.6 meters to 9.1 meters. The borings were continuously sampled using Standard Penetration Test (SPT) methods to determine the consistency, relative density, and approximate strength of the materials sampled. The relation between the SPT blow count, the consistency of the cohesive soils, and the relative density of noncohesive soils (from Terzaghi and Peck, 1948) are as follows:

Noncohesive Soils		Cohesive Soils	
N	Density	N	Consistency
< 4	Very Loose	< 2	Very Soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium	4 - 8	Medium
30 - 50	Dense	8 - 15	Stiff
> 50	Very Dense	15 - 30	Very Stiff
		> 30	Hard

Samples were retained from the drilling along the levees for laboratory testing. The logs of the borings are presented at the end of this appendix.

(2) Laboratory Testing. Laboratory testing was performed on the samples obtained at various depths from the core borings drilled along the proposed levee alignment. Laboratory

tests included grain size analyses, water content determinations, and Atterberg limits. The laboratory test results are included at the end of this appendix.

b. Materials Encountered. The existing geologic profile for the Salinas Levee was defined by the core borings drilled along the proposed levee alignment. The materials encountered consisted predominantly of medium density sands with varying amounts of silt and clay content. Some medium density silty gravels and very stiff low plasticity clays were also encountered along the alignment. Core borings CB-SAL-1 and CB-SAL-2 drilled near the coast revealed an approximately 2.0 meter thick layer of loose and medium density sands containing less than 14 percent finer grained materials overlying medium density gravels. The percentage of fine grained materials within the sands and the densities of the sands generally increased in the samples obtained farther inland. Core borings CB-SAL-14 through CB-SAL-16 revealed dense and very dense sands. The very stiff low plasticity clay materials were found at various depths below the sand layers between CB-SAL-8 and CB-SAL-16. Groundwater was encountered in borings CB-SAL-1 through CB-SAL-14. The depth of the groundwater table increased from 1.0 meter at CB-SAL-1 located near the coast to 6.0 meters at CB-SAL-14 and was greater than the 9.0 meter total depth of drilling for CB-SAL-15 and CB-SAL-16. Information obtained from the subsurface investigations conducted downstream of Puerto Rico Highway 52 should be adequate for construction of the Salinas Levee and the Nigua River channel realignments. Additional information should be obtained along the Salinas Levee alignment upstream of Puerto Rico Highway 52 to adequately define the subsurface conditions for this segment of the levee. The geologic sections representing the conditions encountered are shown on plates B-5, B-6, and B-7.

c. Design Slopes. The Salinas Levee segment downstream of Puerto Rico Highway 52 has average crest heights ranging from 1.5 meters to 5.7 meters. Much of this levee will be constructed immediately adjacent to the existing or realigned Nigua River channel and will have maximum floodside slope heights up to 10.2 meters. The Salinas Levee segment upstream of Puerto Rico Highway 52 will be constructed on relatively even terrain and has a maximum crest height of 3.4 meters. The levee crests will have constant widths of 3.0 meters. The 3.0 meter crest width is the minimum width which will allow for ease of construction. The steepest recommended side slopes will be 1.0 vertical to 2.5 horizontal, which will be flat enough to allow for maintenance equipment to traverse the embankment. The levees will be constructed with materials from the required excavations and from the designated borrow area.

d. Slope Stability. Slope stability analyses were computed by the UTEXAS3 slope stability program. Critical shear surfaces were determined from a circular search using the Spencer procedure. Puerto Rico lies within Seismic Zone 3 and a seismic coefficient of 0.15 was used to compute the effects of an earthquake on slope stability.

Slope stability analyses were performed for several sections along the Salinas Levee alignment using soil strength parameters based upon the nearest core boring and corresponding laboratory test data. End of construction stability analyses using unconsolidated, undrained shear strengths and long term stability analyses using consolidated, drained shear strengths were considered in initial analyses. The levee embankment fill does not contain cohesive soils and the cohesive soils encountered below the levee subgrade did not influence the levee stability, therefore only consolidated, drained strengths in the embankment and the subgrade were relevant for the analyses. Steady seepage and rapid drawdown conditions will not exist because of the very short duration of the flood events. Final analyses of the Salinas Levee were performed using only consolidated, drained soil shear strengths.

Analyses were performed for the most critical levee sections located immediately adjacent to and over the existing Nigua River channel slopes. The lowest factor of safety computed for stability of the Salinas Levee without seismic influence was 1.8. The minimum required factor of safety for this condition is 1.5. The earthquake condition requires a minimum factor of safety of 1.0 and the computed factor of safety for the Salinas Levee was 1.3.

The highest and most critical levee section occurred at levee station 26+00 with an average embankment height of 5.7 meters and a floodside slope vertical height (levee crest to channel invert) of 10.2 meters. The subsurface conditions at this location were based upon core boring CB-SAL-14 and the levee embankment consisted of compacted soils characteristic of the designated borrow area within Camp Santiago. The design strengths and slope stability analysis for this levee section are shown on plate B-10.

e. Seepage. Hydraulic and hydrologic analyses indicate that with the Standard Project Flood (SPF), floodwaters will be present on the levees for less than 7.5 hours. Although pervious materials are present in the levee foundation and embankment, for such short duration flood events, seepage will be minimal. High water stages will not occur long enough for foundation underseepage problems to develop or for through embankment seepage to occur. Unless future hydraulic and hydrologic modeling predict flood water stages present for longer durations, further seepage analyses will not be necessary.

f. Settlement. Minimal settlement of the Salinas Levee is anticipated and would occur during the construction period. The medium and dense materials beneath the levee subgrade will provide a very good foundation for the levee. Overbuilding of the levees to account for potential future settlement will not be necessary.

g. Slope Protection. Velocities for the main river channel and over bank areas were determined by the hydraulic modeling described in Appendix A. Velocities for the main channel are usually much greater than for over bank areas which have more vegetation and irregular topography. Velocities are lower at these points which are farther away from the center of flow. The Salinas Levee segments must be constructed immediately adjacent to the main channel and over bank distances are minimal or nonexistent. For the SPF event, the average channel velocities for the Nigua River channel range from 1.0 to 6.1 meters per second. These velocities were used to design the slope protection.

The Salinas Levee embankment will require revetment on the floodside to protect against erosional velocities generated from storm events up to the SPF. The existing and realigned Nigua River channel slopes located immediately adjacent to the levee will also require protection to maintain the integrity of the flood control system. Existing channel slopes located away from the levee will not require protection. Based upon hydraulic analyses, floodwater velocities do not decrease significantly for events more frequent than the SPF and will cause severe damages to the highly erodible earthen surfaces if not protected.

Gabion mattresses are recommended for protection of the channel and levee side slopes. The gabion protection should extend from the levee crest to the toe of the slope and should be keyed into the ground surface to a minimum depth of 1.0 meter. for locations in which the Nigua River channel is immediately adjacent to the levee, the slope protection should extend continuously from the levee crest to the toe of the channel bottom. Typical sections are shown on plate C-1.

The levee segment downstream of Puerto Rico Highway 52 will experience maximum estimated flood velocities up to 3.5 meters per second and will require a 0.15 meter thick gabion mattress from station 0+00 to station 26+00.

Levee station 26+00 to station 29+63 at the east bridge abutment of Puerto Rico Highway 52 will require a 0.23 meter thick gabion mattress to protect the embankment from velocities up to 4.5 meters per second.

The Puerto Rico Highway 52 east bridge abutment and the highway embankment connecting the proposed levee segments will become a critical part of the flood control system and will require protection against erosion. A 0.30 meter thick gabion mattress extending to station 0+00 of the levee segment upstream of Puerto Rico Highway 52 will be necessary to guard against estimated flood velocities up to 5.5 meters per second.

The remaining Salinas Levee segment upstream of Puerto Rico Highway 52 will experience maximum estimated velocities up to 5.0 meters per second and will require a 0.23 meter thick gabion mattress. The protection should extend from levee station 0+00, continue along the levee and highway slopes, and terminate at the northeast corner of the ramped highway section.

All gabion mattresses should be constructed with zinc coated, PVC sleeved wire. Fill for the 0.15 meter and 0.23 meter thick gabion mattresses should consist of 70 millimeter to 150 millimeter diameter stone. The 0.30 meter thick gabion mattresses will require 100 millimeter to 150 millimeter diameter stone fill. The gabion mattresses should be underlain by a layer of nonwoven filter fabric. The gabion protection should be depressed into the ground with finish grade matching the finish grade of the levee and channel slopes.

3. Coco Levee.

a. Investigations Performed.

(1) Core Borings. Thirteen core borings designated CB-COC-1 through CB-COC-13 were drilled along the proposed Coco Levee alignment in April 1994. The core borings were spaced at approximately 300 meters along the entire Coco Levee alignment as shown on plate B-3. The core borings were drilled to the anticipated depth of influence for levee stability and ranged in depth from 3.6 meters to 9.1 meters. The core borings were advanced by SPT methods previously described in paragraph 2a. of this appendix. Samples were retained from the drilling along the proposed alignment for testing. The logs of the borings are presented at the end of this appendix.

(2) Laboratory Testing. Laboratory testing was performed on the samples obtained at various depths from the core borings drilled along the proposed levee alignment. Laboratory tests included grain size analyses, water content determinations, and Atterberg limits. The laboratory test results are included at the end of this appendix.

b. Materials Encountered. The core borings drilled along the proposed Coco Levee alignment were used to define the existing geologic profile for the proposed levee. All of the borings revealed mostly sands and gravels generally containing less than 15 percent finer grained materials. A surficial layer of medium density sand 1.0 to 2.0 meters in thickness was encountered in each of the borings drilled along the extent of the alignment. This sand layer was underlain by a layer of mostly very dense gravels ranging in thickness from 2.0 meters to more than 8.0 meters (the total depth of sampling). Some dense and very dense sands were encountered beneath the gravel layer. Core boring CB-COC-4 revealed a 2.5 meter thick layer of very stiff low plasticity clay beginning at a depth of 4.0 meters. Groundwater was not encountered during drilling of the Coco Levee alignment. Based upon the overall consistency of the materials encountered, no further subsurface investigations for the Coco Levee alignment should be required. Plates B-8 and B-9 show the geologic sections with these materials.

c. Design Slopes. The Coco Levee has an average crest height of 3.7 meters and a maximum crest height of 4.3 meters. The levee crests will have constant widths of 3.0 meters and the steepest recommended side slopes will be 1.0 vertical to 2.5 horizontal. The crest widths and side slopes will meet the minimum construction and maintenance requirements as described in paragraph 2c. of this appendix. The levee will be constructed with materials from the designated borrow area.

d. Slope Stability. Slope stability analyses were performed for the Coco Levee using UTEXAS3 with the Spencer method to determine critical shear surfaces. Earthquake effects on slope stability were considered.

The Coco Levee is located a significant distance from the Nigua River channel on relatively even terrain with uniform subsurface conditions. Because the conditions along the levee alignment were similar and no weak sections were identified, slope stability analyses were performed for the highest levee sections. End of construction conditions using unconsolidated, undrained shear strengths and long term conditions using consolidated, drained shear strengths were considered in initial analyses. Very small amounts of cohesive soils existed below the levee subgrade and did not influence levee stability. The embankment fill does not contain cohesive soils. Steady seepage and rapid drawdown conditions will not exist because of the very short duration of the flood events. Only consolidated, drained shear strengths were relevant for final analyses of the Coco Levee.

The Coco Levee was stable with a factor of safety of 1.9 without seismic influence. The minimum factor of safety required for this condition is 1.5. The lowest factor of safety computed for the earthquake condition was 1.3 and the minimum required factor of safety is 1.0.

The design strengths and slope stability analysis for the levee section at station 27+00 are shown on plate B-10. The height of the embankment at this section is 4.3 meters. Core boring CB-COC-9 was used to define the subsurface conditions at this location. The embankment consisted of compacted materials characteristic of the soils from the borrow area within Camp Santiago.

e. Seepage. Hydraulic and hydrologic analyses performed for the Salinas Levee portion of the project indicate maximum flood water durations for the SPF event present on the levees for 7.5 hours. For the Coco Levee segment, located upstream of the Salinas Levee segment, flood water will be present on the levees for even shorter durations. The high water stages will not be present long enough to develop foundation underseepage problems or cause through embankment seepage. Further seepage analyses for the Coco Levee will not be required unless longer duration flood events are predicted based upon future hydraulic and hydrologic modeling.

f. Settlement. Very minimal settlement of the Coco Levee is anticipated. The medium dense to predominantly very dense granular soils beneath the levee subgrade will provide excellent founding conditions along the levee alignment. No overbuilding of the levee to account for future settlement will be required.

g. Slope Protection. Velocities for the main channel and over bank areas were determined by the hydraulic modeling described in Appendix A. Velocities for the main channel are usually much higher than for over bank areas which have more vegetation and irregular topography. Velocities are lower at those points farther away from the center of flow. The Coco Levee is located 150 to 600 meters from the Nigua River's main channel. For the SPF event, average channel velocities range from 1.3 to 6.4 meters per second. However, average over bank velocities range from 0.3 to 1.4 meters per second, and velocities at the levee face are expected to be lower than average. The slope protection was designed based upon these velocities.

The Coco Levee will be constructed with highly erodible sand and gravel materials and will require some minimal protection against the overbank velocities generated from storm events up to and including the SPF. Based upon the hydraulic analyses, the maximum estimated flood velocities experienced will be limited to 1.4 meters per second. The levee floodside can be adequately protected against erosion with established and well maintained grass over the earthen embankment. Any erosional damages incurred by the embankment should be promptly repaired to prevent further scour and degradation of the levee.

4. Foundation Conditions for Structures.

a. Drainage Structures. Three culvert structures will be required to pass drainage waters through the Salinas Levee into the floodplain. The drainage structure located north of the railroad tracks will consist of one 60 inch diameter corrugated metal pipe 40 meters in length. The structure north of Puerto Rico Highway 1 will consist of two 60 inch diameter corrugated metal pipes 40 meters in length. The remaining structure is located south of Puerto Rico Highway 52 and will consist of one 60 inch diameter corrugated metal pipe having a length of 60 meters. Flapgates will be placed on the levee floodside of the culverts to prevent backflow during floods. The culverts will experience maximum differential heads during the SPF event around 2.8 meters. There will be an average levee embankment height of 2.7 meters above the culverts. Core borings were not drilled for the drainage structures because the final structure locations were determined after completion of field investigations for this study. Based upon the core borings located along the levee alignment in the vicinity of the structure locations, the culverts will bear in medium density silty sands and should provide good foundation conditions for the structures. Minimal subgrade preparation work is anticipated. The groundwater observed was greater than 4.0 meters below the proposed culvert inverts at all structure locations so no dewatering will be required for construction of the drainage structures. Through seepage and under seepage are not anticipated at the culvert locations based upon the relative hydrostatic heads expected and the short durations of the flood events.

b. Puerto Rico Highway 1 Bridge Replacement. A new bridge will be required where the proposed Salinas Levee and the Nigua River channel intersect Puerto Rico Highway 1. Based upon the subsurface investigations conducted along the Salinas Levee alignment, the bridge foundation will bear in mostly medium density sands and some medium density gravels. Specific subsurface data will be required at the abutment and pier locations for final design of the bridge.

c. Access Roads and Levee Road Ramps. An unpaved access road is proposed west of the Nigua River starting at Puerto Rico Highway 1 and extending north, tying into an existing road located downstream of Puerto Rico Highway 52. The length of the roadway is approximately 1.54 kilometers and will be constructed on existing grade. Based upon the core borings drilled along the nearby Salinas Levee alignment, soils along the proposed access road alignment will likely consist of mostly medium density sands which can easily be compacted and graded for the roadway. Fill material obtained from the project excavations or the designated borrow area will be required to construct a ford where the access road crosses an existing dry streambed. No culverts will be provided for flows under the access road. The access road is located within the floodplain and will be subjected to overtopping and heavy scouring from floodwaters rising above the banks of the Nigua River channel. Maintenance will be required after these events to restore washed out sections of the roadway.

Two road ramps are proposed to provide continuous access along existing roadways across the Salinas Levee. The proposed levee intersects Puerto Rico Highway 1 upstream of Puerto Rico Highway 52 and will require ramping. The other ramp will provide access for an unpaved road crossing the downstream portion of the levee. Fill materials, material placement, and compactive effort at the levee crossings and ramp embankments must conform to Puerto Rico Highway Authority standards.

d. Puerto Rico Highway 52 Embankment. A short segment of the existing Puerto Rico Highway 52 embankment will connect the upstream and downstream segments of the Salinas Levee, providing a continuous barrier of protection against flood waters. The Salinas Levee will tie into the downstream side of the highway embankment at the east bridge abutment. Upstream of the embankment, the levee will tie in approximately 150 meters east of the bridge at the Nigua River.

The original plans have been reviewed and discussion has taken place with the Federal Highway Administration regarding the structural conditions and construction characteristics of the highway embankment and bridge. Construction of Puerto Rico Highway 52 was in conformance to Federal Highway Administration standards for interstate highways which exceed Corps of Engineers' criteria for construction of earthen flood control embankments.

This segment of Puerto Rico Highway 52 was constructed between 1971 and 1973. The average crest width at the location of the levee tie in is 50.0 meters. The average height is 5.0 meters and the side slopes are 1.0 vertical to 2.0 horizontal.

Based upon hydraulic and hydrologic modeling, the proposed flood control project will not adversely affect the existing conditions with regard to flood water stage, duration, and velocity upstream of Puerto Rico Highway 52.

Hydraulic and hydrologic analyses indicate flood waters will be present on the embankment for less than 7.5 hours. The duration of the flood events will not be long enough for foundation underseepage problems to develop or for through seepage to occur.

The highway embankment was inspected by Corps of Engineers' personnel and found to be in very good condition. The only defect to the embankment appeared to be some erosional damages caused by flood waters. Some erosion near the embankment toe at the upstream west embankment has occurred, but has stabilized. Loose riprap originally placed on the abutment slopes was somewhat displaced. With the proposed flood control project, the embankment slopes for the section of highway connecting the Salinas Levee will be protected with gabion mattresses as described in paragraph 2g. of this appendix.

5. Borrow Sources. Material required for construction of the levees will be obtained from the required project excavations and from a designated borrow area within the nearby Camp Santiago Military Reservation. Approximately 95 percent of the materials obtained from the channel realignments and other excavations along the Salinas Levee alignment will be suitable for direct fill placement. Paragraph 3b. of this appendix contains a complete description of the materials expected to be encountered during the excavations. Because of limited project excavations, the majority of the fill materials required to meet the total project fill requirements will be obtained from the designated borrow area located approximately 7.5 kilometers northwest of the project vicinity. Investigations of the materials within the proposed borrow area were conducted in April 1994. Field investigations of the site included four test pits, TP-SAL-1 through TP-SAL-4. The borrow area and test pit locations are shown on plate B-4. The test pits were excavated using a backhoe

to a maximum depth of 2.5 meters. Bulk samples were obtained from the test pits for laboratory testing. Laboratory tests performed included grain size analyses, water content determinations, and standard compaction tests. The logs of the test pits and the laboratory test results are presented at the end of this appendix. Materials within the borrow area generally consisted of silty sands and silty gravels. Some rock fragments were encountered. No groundwater was observed within the limits of the sampling. The natural moisture contents of the materials were well below the optimum moisture contents for all samples tested. Based upon the investigations performed, approximately 85 percent of the material excavated within the borrow area will be suitable for levee construction. The borrow materials can be retrieved by standard excavation techniques and placed in the levee embankment with minimal processing to remove oversized particles.

6. Disposal Area. A designated disposal area is located northwest of the Salinas Levee alignment and immediately south of Puerto Rico Highway 52 as shown on plate B-4. All debris removed during project clearing and grubbing and all other excavated materials unsatisfactory for levee construction will be placed in the designated disposal area.

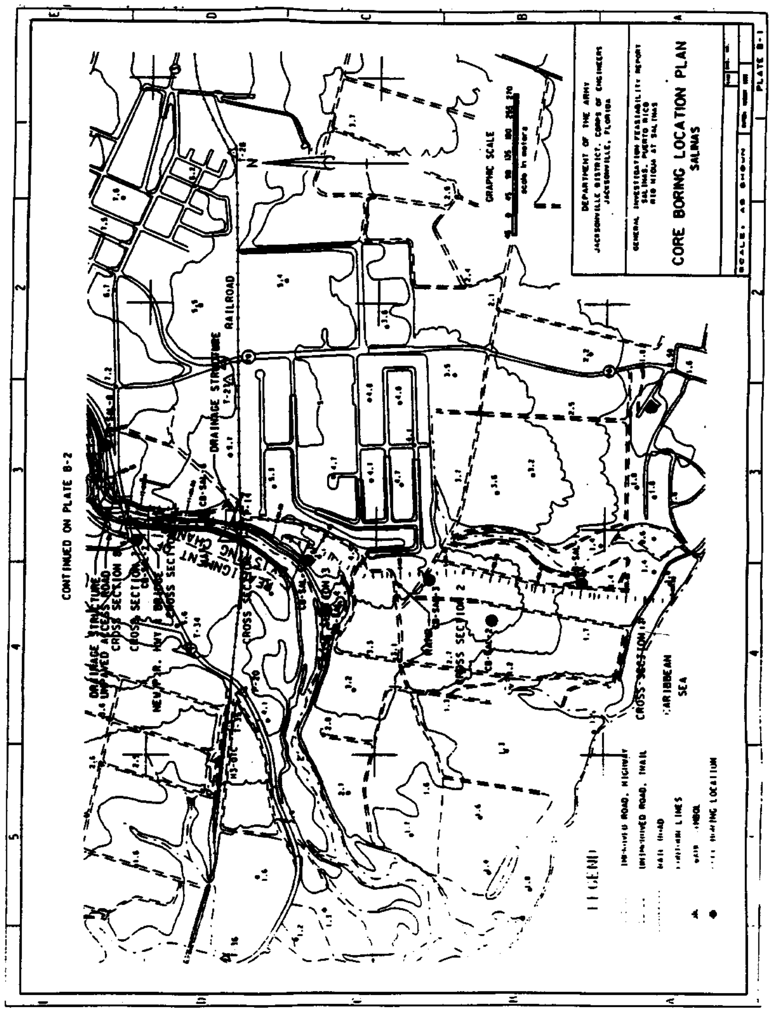
7. Future Investigations. During the Design Memorandum phase, additional subsurface investigations will be conducted to better define conditions along the proposed Salinas Levee alignment, drainage structures, Puerto Rico Highway 1 Bridge, and borrow area.

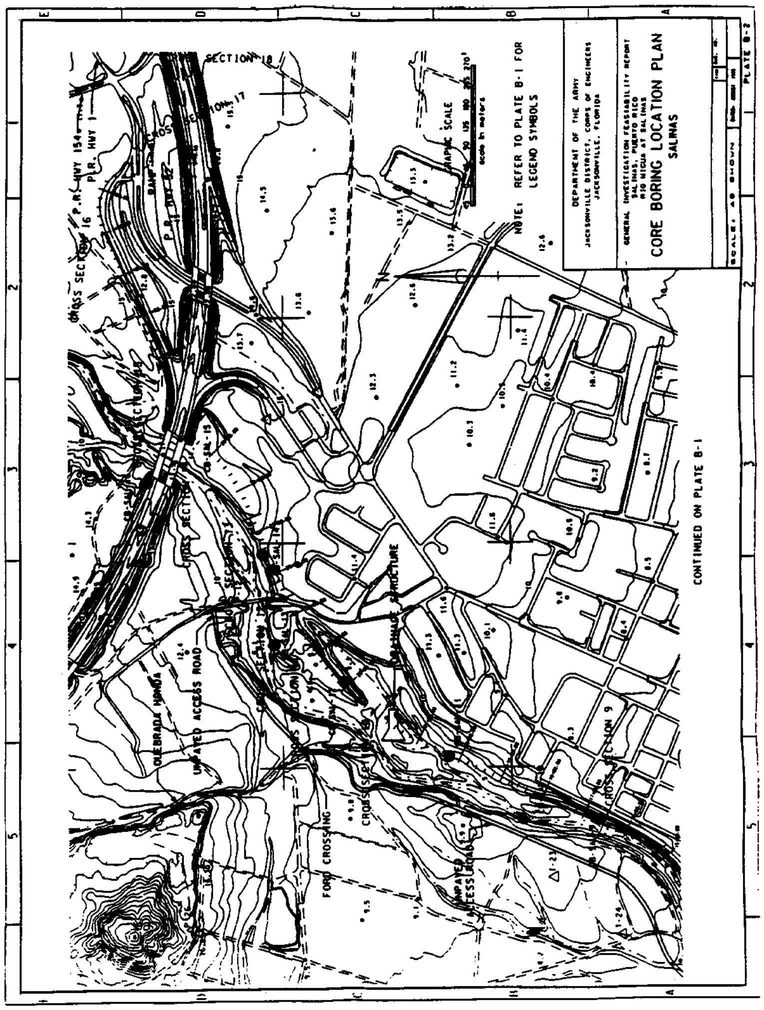
At least two core borings should be drilled along the Salinas Levee alignment upstream of Puerto Rico Highway 52 to adequately define the subsurface conditions for this segment of the levee added during the Feasibility study. The borings should be evenly spaced and drilled to approximate depths of 5.0 meters each.

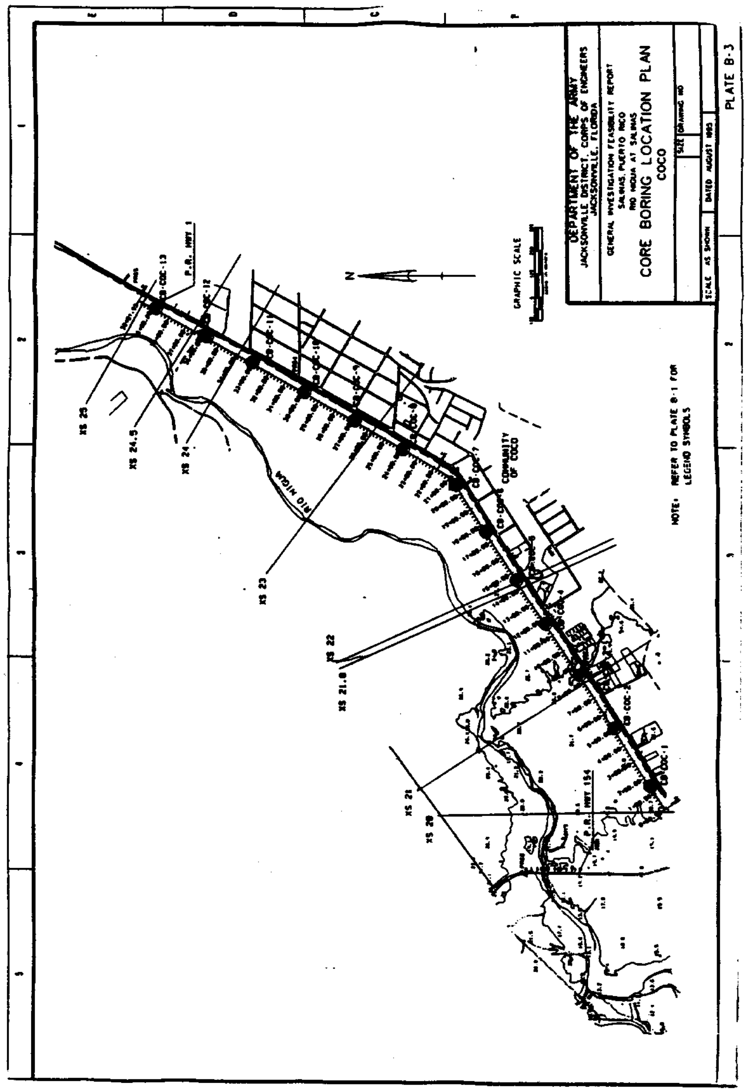
Future project investigations should include drilling one SPT core boring at each drainage structure location to a depth of approximately 7.0 meters to insure that conditions are adequately defined to design the foundations.

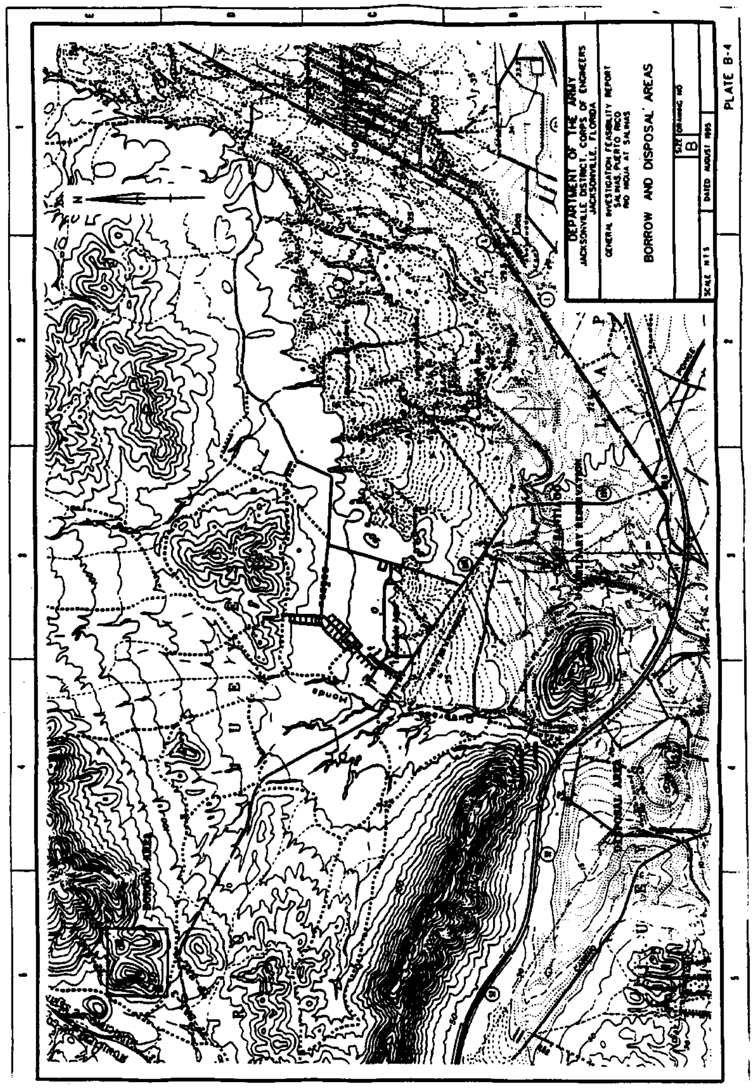
For the Puerto Rico Highway 1 Bridge replacement, specific subsurface data will be required at the abutment and pier locations for final design of the bridge. One SPT core boring should be drilled to approximately 18.0 meters for each abutment and pier after the exact locations are determined.

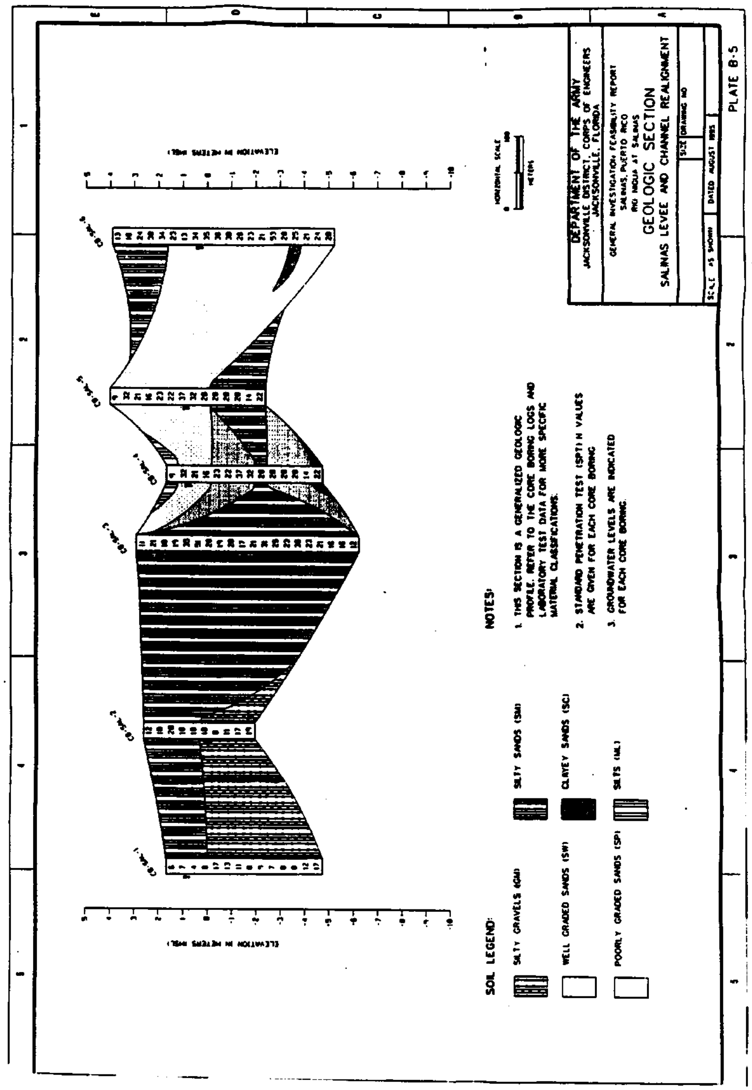
Further investigations should be conducted within the Camp Santiago borrow area to better define the quantity and the character of the materials available for borrow. Core borings should be drilled to determine the depth of suitable borrow material and additional test pits should be excavated to better define the limits of borrow materials.


DEPARTMENT OF THE ARMY
CORE BORING LOCATION PLAN
SALINAS
PLATE B-1
GRAPHIC SCALE
CONTINUED ON PLATE B-2
DRAINAGE STRUCTURE
RAILROAD
CROSS SECTION 2
CARIBBEAN
SEA
LEGEND

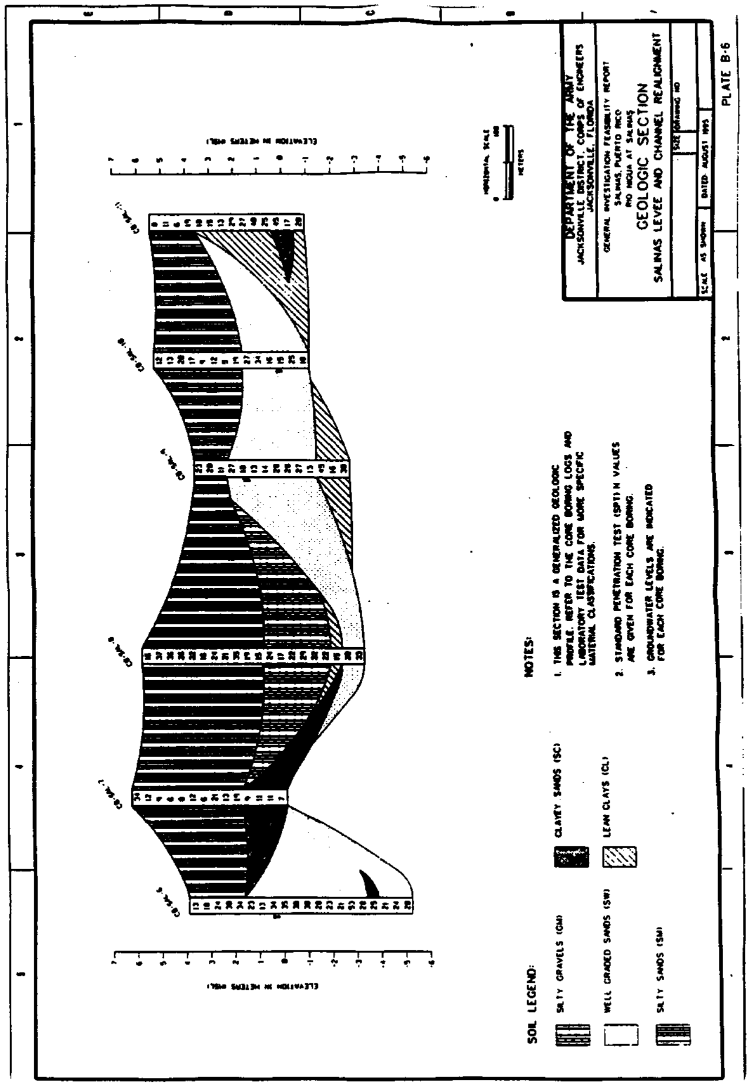

NOTE: REFER TO PLATE B-1 FOR LEGEND SYMBOLS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
CORE BORING LOCATION PLAN
SALINAS
PLATE B-2
CONTINUED ON PLATE B-1
GRAPHIC SCALE
FORD CROSSING
UNPAVED ACCESS ROAD
QUEBRADA HONDA
CROSS SECTION 9
SECTION 18

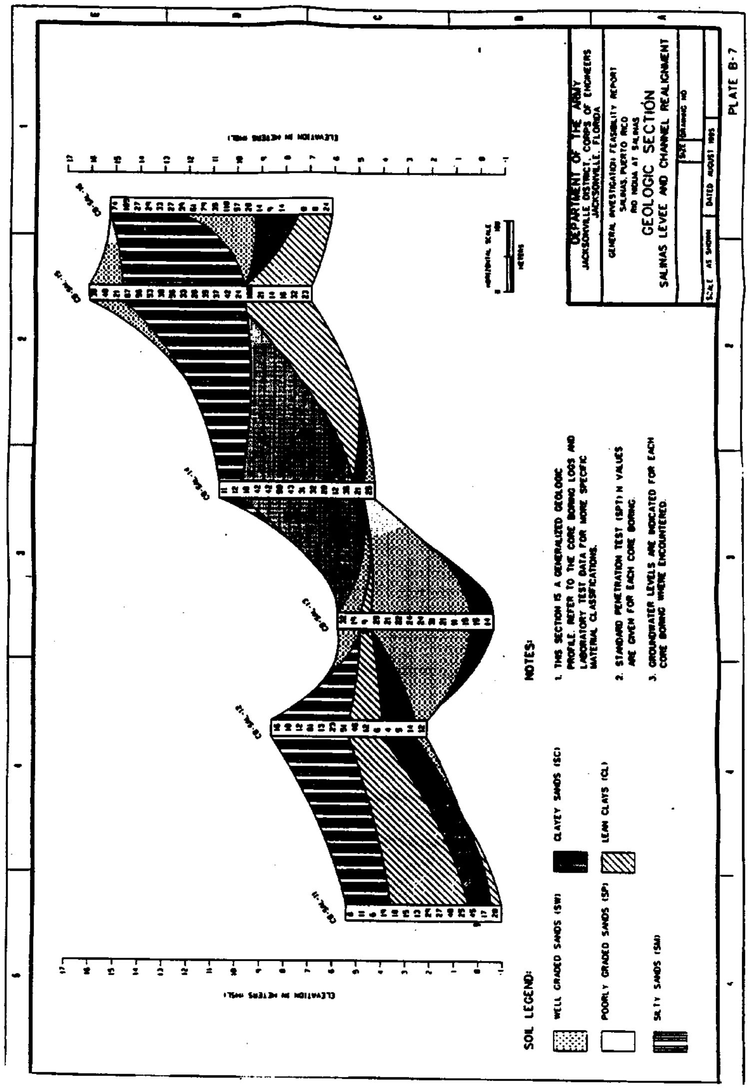

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
CORE BORING LOCATION PLAN
COCO
SCALE AS SHOWN
DATED AUGUST
SIZE
DRAWING NO
PLATE B-3
GRAPHIC SCALE
NOTE: REFER TO PLATE B-1 FOR LEGEND SYMBOLS
COMMUNITY OF COCO
RIO NIGUA
N

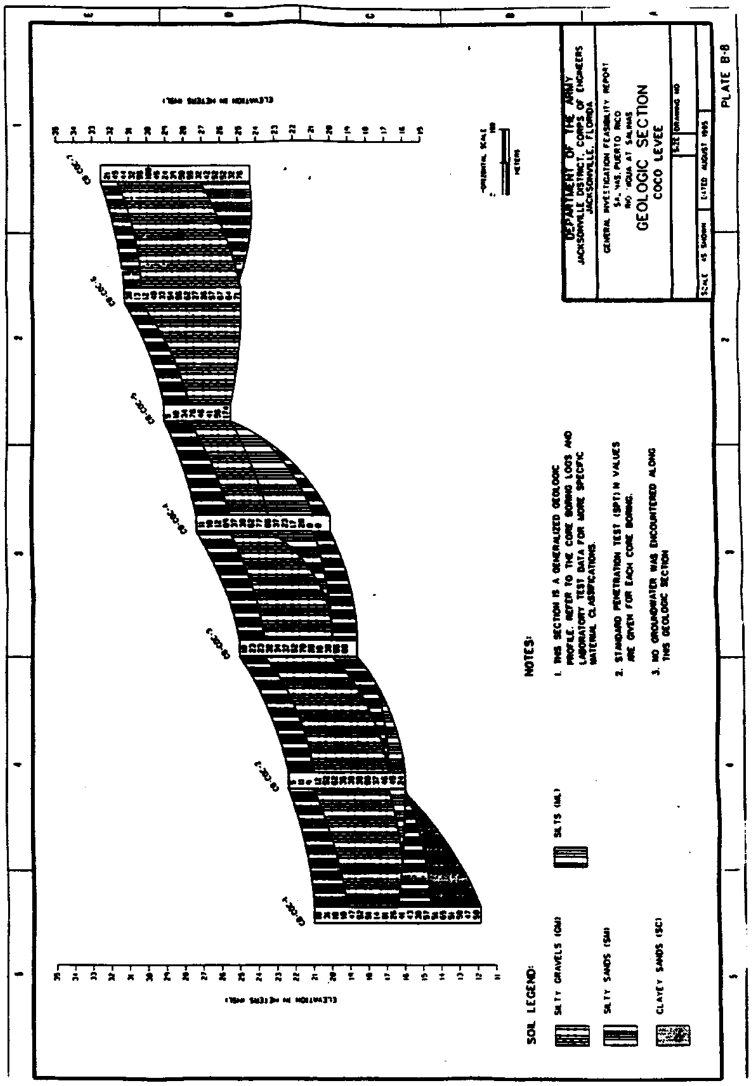

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
BORROW AND DISPOSAL AREAS
DATED AUGUST 1995
PLATE B-4

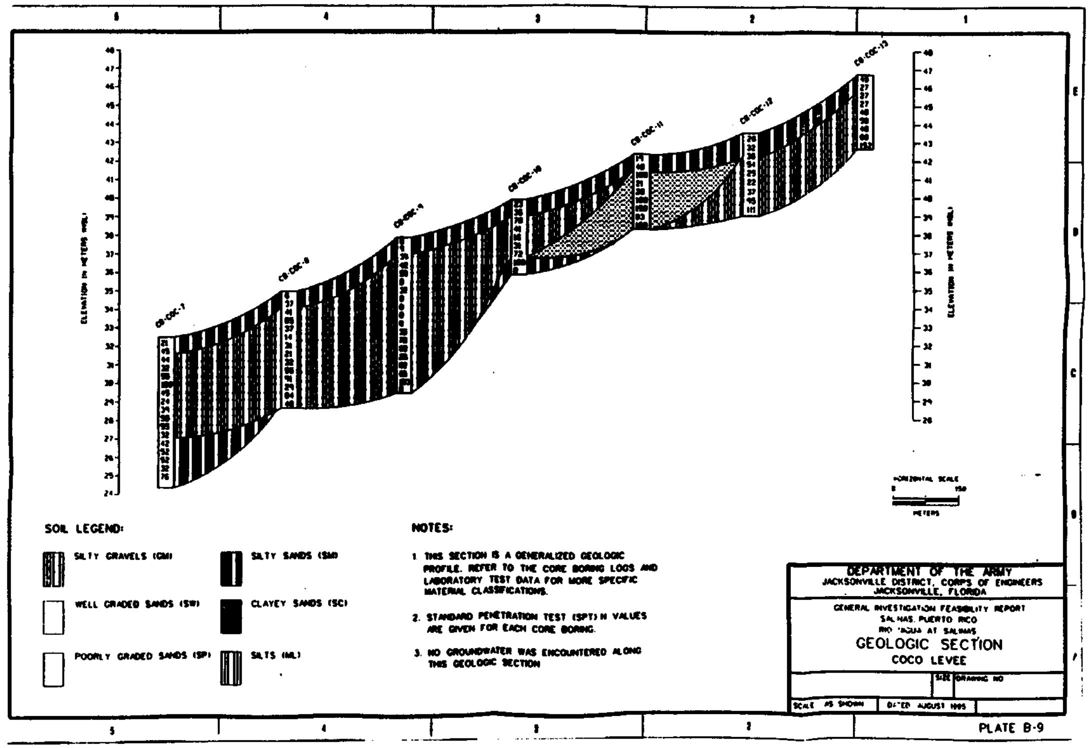


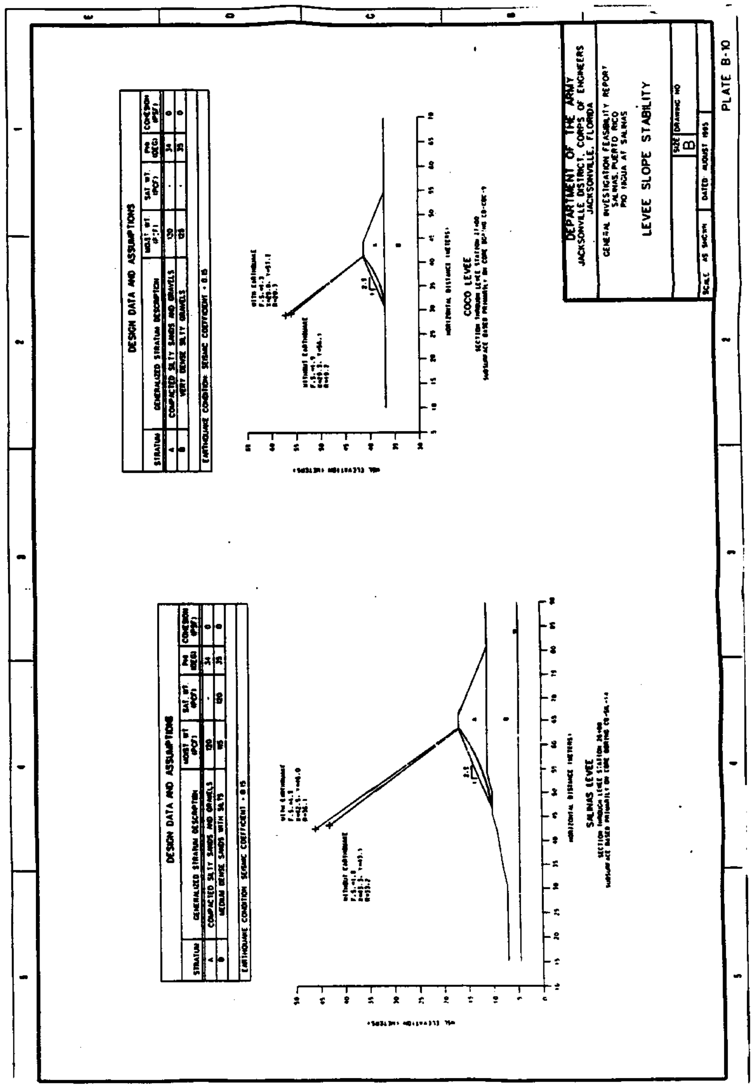
CB-SAL-1
CB-SAL-2
CB-SAL-3
CB-SAL-4
CB-SAL-5
CB-SAL-6
ELEVATION IN METERS (MSL)
SOIL LEGEND:
SILTY GRAVELS (GM)
WELL GRADED SANDS (SW)
POORLY GRADED SANDS (SP)
SILTY SANDS (SM)
CLAYEY SANDS (SC)
SILTS (ML)
NOTES:
1. THIS SECTION IS A GENERALIZED GEOLOGIC PROFILE. REFER TO THE CORE BORING LOGS AND LABORATORY TEST DATA FOR MORE SPECIFIC MATERIAL CLASSIFICATIONS.
2. STANDARD PENETRATION TEST (SPT) N VALUES ARE GIVEN FOR EACH CORE BORING
3. GROUNDWATER LEVELS ARE INDICATED FOR EACH CORE BORING.
HORIZONTAL SCALE
METERS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
GEOLOGIC SECTION
SALINAS LEVEE AND CHANNEL REALIGNMENT
SIZE
DRAWING NO
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-5


DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
GEOLOGIC SECTION
SALINAS LEVEE AND CHANNEL REALIGNMENT
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-6
ELEVATION IN METERS (MSL)
SOIL LEGEND:
SILTY GRAVELS (GM)
WELL GRADED SANDS (SW)
SILTY SANDS (SM)
CLAYEY SANDS (SC)
LEAN CLAYS (CL)
NOTES:
1. THIS SECTION IS A GENERALIZED GEOLOGIC PROFILE. REFER TO THE CORE BORING LOGS AND LABORATORY TEST DATA FOR MORE SPECIFIC MATERIAL CLASSIFICATIONS.
2. STANDARD PENETRATION TEST (SPT) N VALUES ARE GIVEN FOR EACH CORE BORING.
3. GROUNDWATER LEVELS ARE INDICATED FOR EACH CORE BORING.


SOIL LEGEND:
WELL GRADED SANDS (SW)
POORLY GRADED SANDS (SP)
SILTY SANDS (SM)
CLAYEY SANDS (SC)
LEAN CLAYS (CL)
NOTES:
1. THIS SECTION IS A GENERALIZED GEOLOGIC PROFILE. REFER TO THE CORE BORING LOGS AND LABORATORY TEST DATA FOR MORE SPECIFIC MATERIAL CLASSIFICATIONS.
2. STANDARD PENETRATION TEST (SPT) N VALUES ARE GIVEN FOR EACH CORE BORING.
3. GROUNDWATER LEVELS ARE INDICATED FOR EACH CORE BORING WHERE ENCOUNTERED.
ELEVATION IN METERS (MSL)
HORIZONTAL SCALE
METERS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
GEOLOGIC SECTIÓN
SALINAS LEVEE AND CHANNEL REALIGNMENT
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-7


SOIL LEGEND:
SILTY GRAVELS (GM)
SILTY SANDS (SM)
CLAYEY SANDS (SC)
SILTS (ML)
NOTES:
1. THIS SECTION IS A GENERALIZED GEOLOGIC PROFILE. REFER TO THE CORE BORING LOGS AND LABORATORY TEST DATA FOR MORE SPECIFIC MATERIAL CLASSIFICATIONS.
2. STANDARD PENETRATION TEST (SPT) N VALUES ARE GIVEN FOR EACH CORE BORING.
3. NO GROUNDWATER WAS ENCOUNTERED ALONG THIS GEOLOGIC SECTION
ELEVATION IN METERS (MSL)
HORIZONTAL SCALE
METERS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
GEOLOGIC SECTION
COCO LEVEE
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-8


CB-COC-7
CB-COC-8
CB-COC-9
CB-COC-10
CB-COC-11
CB-COC-12
CB-COC-13
ELEVATION IN METERS (MSL)
HORIZONTAL SCALE
0 150
METERS
SOIL LEGEND:
SILTY GRAVELS (GM)
WELL GRADED SANDS (SW)
POORLY GRADED SANDS (SP)
SILTY SANDS (SM)
CLAYEY SANDS (SC)
SILTS (ML)
NOTES:
1. THIS SECTION IS A GENERALIZED GEOLOGIC PROFILE. REFER TO THE CORE BORING LOGS AND LABORATORY TEST DATA FOR MORE SPECIFIC MATERIAL CLASSIFICATIONS.
2. STANDARD PENETRATION TEST (SPT) N VALUES ARE GIVEN FOR EACH CORE BORING.
3. NO GROUNDWATER WAS ENCOUNTERED ALONG THIS GEOLOGIC SECTION
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
GEOLOGIC SECTION
COCO LEVEE
SIZE
DRAWING NO
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-9


DESIGN DATA AND ASSUMPTIONS
STRATUM
GENERALIZED STRATUM DESCRIPTION
MOIST WT (PCF)
SAT. WT. (PCF)
PHI (DEG)
COHESION (PSF)
COMPACTED SILTY SANDS AND GRAVELS
MEDIUM DENSE SANDS WITH SILTS
EARTHQUAKE CONDITION SEISMIC COEFFICIENT = 0.15
SALINAS LEVEE
DESIGN DATA AND ASSUMPTIONS
COMPACTED SILTY SANDS AND GRAVELS
VERY DENSE SILTY GRAVELS
EARTHQUAKE CONDITION SEISMIC COEFFICIENT = 0.15
COCO LEVEE
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GENERAL INVESTIGATION FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
LEVEE SLOPE STABILITY
SIZE
B
DRAWING NO
SCALE AS SHOWN
DATED AUGUST 1995
PLATE B-10

CORE BORING LOGS, TEST PIT LOGS, AND LABORATORY TEST DATA

Hole No.CB-SAL-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2
PROJECT: RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT: See Remarks	
LOCATION (Coordinates or Station): X=544,225 Y=49,373		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
DRILLING AGENCY: SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45	
HOLE NO. (As shown on drawing title and file number): CB-SAL-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0	
		14. TOTAL NUMBER OF CORE BOXES: 1	
NAME OF DRILLER: NICOLAS ANDINO		15. ELEVATION GROUND WATER: 2.48 ft	
DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED		16. DATE HOLE: STARTED 4/30/94 COMPLETED 4/30/94	
		17. ELEVATION TOP OF HOLE: 5.482 Ft.	
THICKNESS OF BURDEN: 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING: 50.85 %	
DEPTH DRILLED INTO ROCK: 0 Ft.		19. SIGNATURE OF GEOLOGIST:	
TOTAL DEPTH OF HOLE: 21.0 Ft.		ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'	
5.5	.0					5.5		0
			(SM) SILTY SAND, some gravel, pale yellowish brown.	67	1	SPLIT SPOON 4.0	2 / 2 / 4	
				100	2	" 2.5	2 / 3 / 4	2.5
				38	3	" 1.0	1 / 1 / 3	
.0	5.5			33	4	" -.5	2 / 3 / 5	5
			(GM) SILTY GRAVEL, dark yellowish brown.	28	5	" -2.0	10 / 10 / 7	7.5
				67	6	" -3.5	7 / 7 / 6	
				78	7	" -5.0	9 / 7 / 4	10
				33	8	" -6.5	5 / 5 / 3	
				22	9	" -8.0	3 / 4 / 6	12.5
				33	10	" -9.5	7 / 4 / 3	15
				38	11	" -11.0	3 / 3 / 5	
				33	12	" -12.5	4 / 3 / 5	17.5
				56	13	" -14.0	5 / 6 / 6	
-15.5	21.0			56	14	" -15.5	7 / 7 / 10	20
						(continued)		22.5

NB FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. AR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-1

Hole No.CB-SAL-1

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 5.482 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 1/2'
-17.0	22.5		Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2.0" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM -0.5 4	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-1

Hole No.CB-SAL-2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=543,859 Y=50,016	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 10 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: -.40 ft.
	16. DATE HOLE: STARTED 4/30/94 COMPLETED 4/30/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 8.599 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 75.8 %
9. TOTAL DEPTH OF HOLE: 15.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon (Elev.)	BLOWS/.5'
8.6	.0	(SM) SILTY SAND, some gravel, pale yellowish brown.	56	1	8.6 SPLIT SPOON	4, 5, 7
			67	2	7.1 "	8, 5, 5
			89	3	5.6 "	4, 6, 14
			100	4	4.1 "	9, 10, 8
			56	5	2.6 "	5, 6, 10
1.1	7.5	(GM) SILTY GRAVEL, dark yellowish brown.	78	6	1.1 "	8, 8, 10
			89	7	-.4 "	13, 5, 3
			100	8	-1.9 "	6, 6, 5
			67	9	-3.4 "	3, 6, 11
			56	10	-4.9 "	7, 8, 11
-6.4	15.0				-6.4	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2.0" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
(SM)	1.1	5	--	--	--

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-2

Hole No.CB-SAL-3

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=544,250 Y=50,936	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 20 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: -2.43 ft.
	16. DATE HOLE: STARTED 4/30/94 COMPLETED 4/30/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 8.587 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 53.3 %
9. TOTAL DEPTH OF HOLE: 30.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"	
8.6	.0					8.6		0
			(SM) SILTY SAND, some gravel, yellowish brown.	67	1	SPLIT SPOON 8.1	2, 4, 7	
				78	2	" 6.6	6, 9, 12	2.5
				78	3	" 5.1	7, 10, 8	
				67	4	" 3.6	12, 10, 9	5
				98	5	" 2.1	7, 14, 21	7.5
				56	6	" .6	12, 17, 34	
				33	7	" -.9	10, 17, 11	10
-.9	10.5		(SM) SILTY SAND, ocasionally gravelly, dark-yellowish brown.	33	8	" -2.4	9, 7, 12	
				38	9	" -3.9	10, 10, 10	12.5
				33	10	" -5.4	12, 7, 10	15
				67	11	" -6.9	7, 8, 13	
				89	12	" -8.4	22, 14, 17	17.5
				67	13	" -9.9	12, 14, 11	
				44	14	" -11.4	10, 16, 7	20
				38	15	" -12.9	12, 16, 14	22.5
						(continued)		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-SAL-3

Hole No.CB-SAL-3

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE: 9.567 Ft. | SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT | INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-12.9	22.5					-12.9	
				28	16	-14.4	22 13 10
				33	17	-15.9	10 14 7
				67	18	-17.4	7 10 8
				44	19	-18.9	8 10 6
-20.4	30.0			60	20	-20.4	5 6 6
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM -6.9 18	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: RIO NIGUA PROJECT | HOLE NUMBER: CB-SAL-3

Hole No. CB-SAL-4

DRILLING LOG

- DIVISION: South Atlantic
- INSTALLATION: Jacksonville District — SHEET 1 OF 2
- 1. PROJECT: RIO NIGUA PROJECT
- 2. LOCATION (Coordinates or Station): X=644,028 Y=61,207
- 3. DRILLING AGENCY: SUELOS INC.
- 4. HOLE NO. (As shown on drawing title and file number): CB-SAL-4
- 5. NAME OF DRILLER: NICOLAS ANDINO
- 6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
- 7. THICKNESS OF BURDEN: 0 Ft.
- 8. DEPTH DRILLED INTO ROCK: 0 Ft.
- 9. TOTAL DEPTH OF HOLE: 21.0 Ft.
- 10. SIZE AND TYPE OF BIT: See Remarks
- 11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
- 12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
- 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
- 14. TOTAL NUMBER OF CORE BOXES: 1
- 15. ELEVATION GROUND WATER: 2.287 ft.
- 16. DATE HOLE: STARTED 4/30/94 COMPLETED 4/30/94
- 17. ELEVATION TOP OF HOLE: 5.482 Ft.
- 18. TOTAL CORE RECOVERY FOR BORING: 50.85 %
- 19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV. (top–bottom)	DEPTH (top–bottom)	CLASSIFICATION OF MATERIALS (Description)
5.5 – 4.0	.0 – 1.5	(ML) SILTS, sandy dark yellowish brown.
4.0 – -.5	1.5 – 6.0	(SW) SANDY GRAVEL, dark yellowish brown.
-.5 – -6.5	6.0 – 12.0	(SP) POORLY GRADED SAND, dark yellowish brown-dark olive.
-6.5 – -8.0	12.0 – 13.5	(SM) SILTY SAND, olive-dark olive brown.
-8.0 – -14.0	13.5 – 19.5	(SP) POORLY GRADED SAND, olive-olive brown.
-14.0 – -15.5	19.5 – 21.0	(SC) CLAYEY SAND, dark olive brown.

CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon (elev. top–bottom)	BLOWS/.5'
78	1	5.5 – 4.0 SPLIT SPOON	3, 4, 5
28	2	4.0 – 2.5 "	16, 16, 16
22	3	2.5 – 1.0 "	2, 6, 13
38	4	1.0 – -.5 "	12, 14, 2
89	5	-.5 – -2.0 "	10, 7, 16
67	6	-2.0 – -3.5 "	12, 10, 12
56	7	-3.5 – -5.0 "	7, 21, 16
67	8	-5.0 – -6.5 "	12, 16, 16
89	9	-6.5 – -8.0 "	8, 10, 10
78	10	-8.0 – -9.5 "	9, 11, 9
67	11	-9.5 – -11.0 "	7, 10, 10
56	12	-11.0 – -12.5 "	7, 10, 10
78	13	-12.5 – -14.0 "	4, 5, 9
67	14	-14.0 – -15.5 "	7, 12, 10

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-SAL-4

Hole No.CB-SAL-4

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 5.482 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-17.0	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SP -5.0 25	

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-4

Hole No. CB-SAL-5

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=644,392 Y=51,338	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-5	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: 2.674 ft.
	16. DATE HOLE: STARTED 4/30/94 COMPLETED 4/30/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 13.174 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 61.0 %
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 0.5'
13.2	.0					13.2	
			(SW) WELL GRADED SAND, dark yellowish brown.	67	1	SPLIT SPOON 11.7	3, 4, 6
				100	2	" 10.2	16, 16, 16
				33	3	" 8.7	2, 8, 13
				66	4	" 7.2	12, 14, 2
				66	5	" 5.7	10, 7, 16
				100	6	" 4.2	12, 10, 12
				66	7	" 2.7	7, 21, 16
				33	8	" 1.2	12, 16, 16
-.3	13.5			38	9	" -.3	8, 10, 10
			(SM) SILTY SAND, ocasionally gravelly, yellowish brown-dark olive.	100	10	" -1.8	9, 11, 9
				100	11	" -3.3	7, 10, 10
				44	12	" -4.8	7, 10, 10
				33	13	" -6.3	4, 5, 9
-7.8	21.0			38	14	" -7.8	7, 12, 10

(continued)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-5

Hole No.CB-SAL-5

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 13.174 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-9.3	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM -3.3 32	

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-5

Hole No. CB-SAL-6

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2

PROJECT RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT See Remarks
LOCATION (Coordinates or Station) X=544,717 Y=52,096	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
DRILLING AGENCY TELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL CME-45
HOLE NO. (As shown on drawing title and file number) CB-SAL-6	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 20 undisturbed: 0
NAME OF DRILLER NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES 1
DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER .821
	16. DATE HOLE STARTED 4/30/94 COMPLETED 4/30/94
	17. ELEVATION TOP OF HOLE 12.821 Ft.
THICKNESS OF BURDEN 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 57.0 %
DEPTH DRILLED INTO ROCK 0 Ft.	19. SIGNATURE OF GEOLOGIST
TOTAL DEPTH OF HOLE 30.0 Ft.	ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"
12.8	.0					12.8	
			(SM) SILTY SAND, yellowish brown, some gravel,	67	1	SPLIT SPOON / 11.3	5, 6, 7
				33	2	" / 9.8	8, 9, 10
				66	3	" / 8.3	13, 14, 10
				60	4	" / 6.8	10, 12, 18
5.3	7.5			80	5	" / 5.3	20, 19, 16
			(SM) WELL GRADED SAND, trace silts, dark-yellowish brown.	100	6	" / 3.8	13, 10, 13
				33	7	" / 2.3	8, 6, 7
				56	8	" / .8	8, 14, 20
				56	9	" / -.7	33, 18, 17
				67	10	" / -2.2	32, 20, 18
				56	11	" / -3.7	21, 16, 14
				78	12	" / -5.2	14, 14, 14
				56	13	" / -6.7	14, 12, 11
				80	14	" / -8.2	13, 10, 11
				67	15	" / -9.7	13, 23, 30
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-6

Hole No.CB-SAL-6

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE 12.821 Ft. | SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT | INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
-9.7	22.5					-9.7	
-11.2	24.0			33	16	" -11.2	23 / 16 / 12
-12.7	25.5		(SC) CLAYEY SAND, olive brown, some gravel.	44	17	" -12.7	14 / 16 / 9
			(SW) WELL GRADED SAND, dark yellowish brown.	66	18	" -14.2	7 / 10 / 11
				33	19	" -15.7	11 / 14 / 10
-17.2	30.0			22	20	" -17.2	8 / 10 / 10

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SW	6.8	5			

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: RIO NIGUA PROJECT | HOLE NUMBER: CB-SAL-6

Hole No. CB-SAL-7

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=644,520 Y=52,628	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-7	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: 2.492 ft
	16. DATE HOLE: STARTED 4/29/84 COMPLETED 4/29/84
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 20.492 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 79.0 %
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
20.5	.0				20.5	
		(SM) SILTY SAND, dark yellowish brown some gravel.	78	1	SPLIT SPOON 18.0	8, 15, 10
			67	2	" 17.5	7, 6, 6
			78	3	" 16.0	4, 4, 5
			80	4	" 14.5	6, 3, 3
			100	5	" 13.0	4, 4, 4
			67	6	" 11.5	4, 6, 6
			100	7	" 10.0	4, 3, 3
			100	8	" 8.5	7, 9, 12
			80	9	" 7.0	4, 6, 7
			100	10	" 5.5	7, 10, 9
5.5	15.0	(SC) CLAYEY SAND, dark yellowish brown, black moltted. Below elevation 2.5 some silty sand.	100	11	" 4.0	4, 4, 5
			100	12	" 2.5	5, 5, 6
			100	13	" 1.0	4, 5, 6
-.5	21.0		44	14	" -.5	3, 3, 4

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-SAL-7

Hole No.CB-SAL-7

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 20.492 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-2.0	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (I-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM 1.0 22	

22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-7

Hole No.CB-SAL-8

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2
1. PROJECT RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=645,219 Y=52,795		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL CME-45	
4. HOLE NO. (As shown on drawing title and file number) CB-SAL-8		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 20 undisturbed: 0	
5. NAME OF DRILLER NICOLAS ANDINO		14. TOTAL NUMBER OF CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER 1.27 ft.	
		16. DATE HOLE STARTED 4/30/94 COMPLETED 4/30/94	
7. THICKNESS OF BURDEN 0 Ft.		17. ELEVATION TOP OF HOLE 19.127 Ft.	
8. DEPTH DRILLED INTO ROCK 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 78.0 %	
9. TOTAL DEPTH OF HOLE 30.0 Ft.		19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'	
19.1	.0					19.1		0
			(SM) SILTY SAND, pale yellowish brown, some gravel.	67	1	SPLIT SPOON 17.6	8 6 10	
				58	2	" 16.1	9 12 25	2.5
				89	3	" 14.6	18 16 20	
				44	4	" 13.1	36 18 8	5
				100	5	" 11.6	8 10 12	7.5
				56	6	" 10.1	10 9 7	
				100	7	" 8.6	13 2 22	10
				89	8	" 7.1	15 10 11	
				100	9	" 5.6	17 19 16	12.5
				78	10	" 4.1	23 12 7	15
2.6	16.5			100	11	" 2.6	10 10 5	
			(GM) SILTY GRAVEL, some gravelly sand, dark yellowish brown.	67	12	" 1.1	6 7 17	17.5
				56	13	" -.4	10 9 8	
				100	14	" -1.9	9 8 14	20
				44	15	" -3.4	19 22 7	22.5
						(continued)		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	C SAL-8

Hole No.CB-SAL-8

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE: 19.127 Ft. | SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT | INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
-3.4	22.5					-3.4	
				44	16	- -4.9	10 / 12 / 10
-6.4	25.5			67	17	- -6.4	10 / 12 / 10
-7.9	27.0		(CL) CLAY, sandy yellowish brown.	56	18	- -7.9	9 / 7 / 8
			(SW) WELL GRADED SAND, some silts, dark-yellowish brown.	67	19	- -9.4	10 / 9 / 11
-10.9	30.0			100	20	- -10.9	14 / 12 / 21

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SW	11.6	9			

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT | HOLE NUMBER: CB-SAL-8

Hole No. CB-SAL-9

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station): X=545,865 Y=53,504		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45	
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-9		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0	
5. NAME OF DRILLER: NICOLAS ANDINO		14. TOTAL NUMBER OF CORE BOXES: 1	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER: 4.377 ft	
		16. DATE HOLE: STARTED 4/29/94 COMPLETED 4/29/94	
7. THICKNESS OF BURDEN: 0 Ft.		17. ELEVATION TOP OF HOLE: 11.877 Ft.	
8. DEPTH DRILLED INTO ROCK: 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING: 68.0 %	
9. TOTAL DEPTH OF HOLE: 21.0 Ft.		19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5
11.9	.0					11.9	
			(SM) SILTY SAND, dark yellowish brown, some gravel.	67	1	SPLIT SPOON 10.4	6, 10, 13
				56	2	" 8.9	4, 9, 11
7.4	4.5			67	3	" 7.4	3, 4, 7
			(SW) WELL GRADED SAND, gravelly, dark grayish brown.	67	4	" 5.9	11, 11, 16
				56	5	" 4.4	8, 9, 9
				89	6	" 2.9	7, 6, 7
				89	7	" 1.4	7, 7, 7
				100	8	" -.1	6, 11, 17
				78	9	" -1.6	10, 11, 17
				56	10	" -3.1	12, 12, 15
-4.6	16.5			67	11	" -4.6	9, 7, 6
			(CL) CLAY, sandy yellowish brown, some gravel.	67	12	" -6.1	13, 20, 25
				38	13	" -7.6	7, 7, 9
-9.1	21.0			56	14	" -9.1	8, 14, 16

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

(continued)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-9

Hole No.CB-SAL-9

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 11.877 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
-10.6	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SW -1.6 8	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-9

Hole No.CB-SAL-10

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=545,878 Y=54,048	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-10	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
7. THICKNESS OF BURDEN: 0 Ft.	16. DATE HOLE: STARTED 4/29/94 COMPLETED 4/29/94
8. DEPTH DRILLED INTO ROCK: 0 Ft.	17. ELEVATION TOP OF HOLE: 17.303 Ft.
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 68.0 %
	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
17.3	.0				17.3	
		(SM) SILTY SAND, brown pale brown some gravel.	44	1	SPLIT SPOON 15.8	3, 6, 6
			67	2	" 14.3	4, 6, 7
			56	3	" 12.8	6, 10, 10
			56	4	" 11.3	7, 9, 8
			78	5	" 9.8	4, 5, 4
			100	6	" 8.3	8, 6, 6
			89	7	" 6.8	4, 2, 3
5.3	12.0		67	8	" 5.3	7, 10, 9
		(SW) WELL GRADED SAND, gravelly, dark yellowish brown.	56	9	" 3.8	10, 13, 14
			33	10	" 2.3	14, 16, 18
			33	11	" .8	8, 10, 6
			100	12	" -.7	6, 7, 8
			78	13	" -2.2	10, 12, 13
-3.7	21.0		100	14	" -3.7	8, 8, 10

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-SAL-10

Hole No.CB-SAL-10

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 17.303 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-5.2	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM 8.3 8	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-10

Hole No.CB-SAL-11

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=546,337 Y=54,583	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-11	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: -.20
	16. DATE HOLE: STARTED 4/28/94 COMPLETED 4/28/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 17.800 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
17.8	.0				17.8	
		(SM) SIL SAND, yellowish brown, some gravel.	100	1	SPLIT SPOON 16.3	2 3 5
			100	2	" 14.8	4 5 6
			100	3	" 13.3	3 3 3
11.8	6.0		100	4	" 11.8	10 7 12
		(CL) CLAY, sandy dark yellowish brown. Below elevation 8.8 ft. some clayey sand.	100	5	" 10.3	5 8 10
			100	6	" 8.8	8 8 7
			100	7	" 7.3	3 5 8
			100	8	" 5.8	10 11 18
			100	9	" 4.3	9 11 16
			100	10	" 2.8	12 20 20
1.3	16.5		100	11	" 1.3	4 10 15
		(SC) CLAYEY SAND, dark yellowish brown, some gravel.	100	12	" -.2	16 22 23
-1.7	19.5		100	13	" -1.7	8 9 8
-3.2	21.0	(CL) CLAY, sandy, yellowish brown.	100	14	" -3.2	6 8 12
					(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-11

Hole No.CB-SAL-11

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 17.800 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
-4.7	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SC -2.0 12 44 26 18	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-11

Hole No.CB-SAL-12

ILLING LOG | DIVISION South Atlantic | INSTALLATION Jacksonville District | SHEET 1 OF 2

CT NIGUA PROJECT

TION (Coordinates or Station) 46,885 Y=55,355

ING AGENCY LOS INC.

E NO. (As shown on drawing title file number) CB-SAL-12

AE OF DRILLER NICOLAS ANDINO

6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED

7. THICKNESS OF BURDEN 0 Ft.

8. DEPTH DRILLED INTO ROCK 0 Ft.

9. TOTAL DEPTH OF HOLE 21.0 Ft.

10. SIZE AND TYPE OF BIT See Remarks

11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL

12. MANUFACTURER'S DESIGNATION OF DRILL CNE-45

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 14 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES 1

15. ELEVATION GROUND WATER 9.976 ft.

16. DATE HOLE STARTED 4/27/94 COMPLETED 4/27/94

17. ELEVATION TOP OF HOLE 27.976 Ft.

18. TOTAL CORE RECOVERY FOR BORING 84.0 %

19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
28.0	.0					28.0	
			(SM) SILTY SAND, yellowish brown, some gravel.	100	1	SPLIT SPOON 26.5	8 9 7
				100	2	" 25.0	7 9 9
				100	3	" 23.5	6 8 8
				100	4	" 22.0	5 25 36
				100	5	" 20.5	6 6 7
				100	6	" 19.0	15 18 5
17.5	10.5			100	7	" 17.5	5 10 32
			(CL) CLAY, sandy, dark yellowish brown.	100	8	" 16.0	18 32 14
				100	9	" 14.5	5 7 5
13.0	15.0			100	10	" 13.0	9 2 4
			(SC) CLAYEY SAND, dark yellowish brown, some gravel.	100	11	" 11.5	2 2 2
				100	12	" 10.0	6 2 3
8.5	19.5			100	13	" 8.5	4 8 6
7.0	21.0		(SC) sandy yellowish brown.	100	14	" 7.0	12 6 6
						(continued)	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT RIO NIGUA PROJECT | HOLE NUMBER CB-SAL-12

Hole No.CB-SAL-12

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: 27.976 Ft.		SHEET 2 OF 2
PROJECT: RIO NIGUA PROJECT	INSTALLATION: Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
5.5	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)	
						LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM [illegible] 7 NP NP NP	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-12

Hole No.CB-SAL-13

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	SHEET 1 OF 2
1. PROJECT	RIO NIGUA PROJECT
2. LOCATION (Coordinates or Station)	X=547,152 Y=55,833
3. DRILLING AGENCY	SUELOS INC.
4. HOLE NO. (As shown on drawing title and file number)	CB-SAL-13
5. NAME OF DRILLER	NICOLAS ANDINO
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN	0 Ft.
8. DEPTH DRILLED INTO ROCK	0 Ft.
9. TOTAL DEPTH OF HOLE	21 Ft.
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	CME-45
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	disturbed: 14 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES	1
15. ELEVATION GROUND WATER	15.108 ft.
16. DATE HOLE	STARTED 4/27/94 COMPLETED 4/27/94
17. ELEVATION TOP OF HOLE	19.108 Ft.
18. TOTAL CORE RECOVERY FOR BORING	80.0 %
19. SIGNATURE OF GEOLOGIST	ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
19.1	.0				19.1	
		(SW) WELL GRADED SAND gravelly, yellowish brown.	78	1	SPLIT SPOON 17.6	8 / 13 / 19
16.1	3.0		78	2	" 16.1	18 / 14 / 5
14.6	4.5	(CL) CLAY, sandy yellowish brown.	44	3	" 14.6	2 / 5 / 4
		(SW) WELL GRADED SAND, some silty sand, yellowish brown.	67	4	" 13.1	8 / 13 / 12
			78	5	" 11.6	7 / 10 / 11
			100	6	" 10.1	9 / 8 / 14
			100	7	" 8.6	10 / 12 / 12
			44	8	" 7.1	10 / 10 / 14
			67	9	" 5.6	13 / 13 / 18
			67	10	" 4.1	10 / 11 / 10
			100	11	" 2.6	4 / 6 / 5
1.1	18.0		100	12	" 1.1	6 / 6 / 9
		(SC) CLAYEY SAND, yellowish brown.	100	13	" -.4	4 / 5 / 10
-1.9	21.0		100	14	" -1.9	4 / 5 / 9

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-13

Hole No.CB-SAL-13

DRILLING LOG (Cont. Sheet)

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 19.108 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
-3.4	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)	

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
GM	13.1	7	NP	NP	NP

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-13

Hole No.CB-SAL-14

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=547,817 Y=55,919	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-14	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: 16.052 ft.
	16. DATE HOLE: STARTED 4/28/94 COMPLETED 4/28/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 35.052 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 80.0 %
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6 in.
35.1	0					35.1	
			(SM) SILTY SAND, pale yellowish brown.	33	1	SPLIT SPOON 33.6	2, 4, 7
32.1	3.0			33	2	" 32.1	4, 6, 6
			(SP) POORLLY GRADED SAND, silty, dark yellowish brown-dark brown.	56	3	" 30.6	5, 7, 11
				33	4	" 29.1	86, 18, 24
				28	5	" 27.6	10, 19, 23
				56	6	" 26.1	27, 22, 28
				56	7	" 24.6	18, 23, 20
				100	8	" 23.1	20, 15, 16
				78	9	" 21.6	24, 15, 17
				78	10	" 20.1	12, 14, 14
				67	11	" 18.6	13, 10, 2
17.1	18.0			38	12	" 17.1	15, 16, 19
15.6	19.5		(SC) CLAYEY SAND, dark yellowish brown.	56	13	" 15.6	6, 12, 9
14.1	21.0		(SW) WELL GRADED SAND, dark yellowish brown (SW).	78	14	" 14.1	10, 12, 13

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-SAL-14

Hole No.CB-SAL-14

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE	SHEET 2 OF 2
35.052 Ft.	

PROJECT	INSTALLATION
RIO NIGUA PROJECT	Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
12.6	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SP 16.6 2 NP NP NP	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-14

Hole No. CB-SAL-15

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=548,887 Y=56,437	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-15	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 20 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 5/2/94 COMPLETED 5/2/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 52.697 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 79.8 %
9. TOTAL DEPTH OF HOLE: 30.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
52.7	.0				52.7	
		(SM) SILTY SAND, gravelly, light gray, some calcareous material	100	1	SPLIT SPOON 51.2	8, 12, 16
			100	2	" 49.7	28, 28, 20
48.2	4.5		78	3	" 48.2	14, 10, 11
		(SM) SILTY SAND, gravelly, olive-olive gray. Below elevation 42.2 some poorly graded sand.	80	4	" 46.7	17, 33, 54
			100	5	" 45.2	61, 23, 33
			33	6	" 43.7	29, 22, 31
			56	7	" 42.2	56, 20, 18
			89	8	" 40.7	14, 13, 43
			67	9	" 39.2	63, 17, 16
			78	10	" 37.7	18, 12, 14
			89	11	" 36.2	21, 14, 21
			89	12	" 34.7	22, 22, 15
			78	13	" 33.2	15, 15, 27
31.7	21.0		44	14	" 31.7	15, 14, 10
		(CL) CLAY, silty, yellowish brown, some fine sand.	100	15	" 30.2	72, 96, 84
					(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-15

Hole No.CB-SAL-15

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: 52.697 Ft.

SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5 ft.
30.2	22.5					30.2	
				100	16	"	11
							11
						28.7	10
				100	17	"	6
							6
						27.2	8
				78	18	"	9
							6
						25.7	8
				72	19	"	11
							16
						24.2	16
				56	20	"	11
							11
22.7	30.0					22.7	12

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SM	40.7	2	NP	NP	NP

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT: RIO NIGUA PROJECT

HOLE NUMBER: CB-SAL-15

Hole No.CB-SAL-16

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=648,336 Y=56,739	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-SAL-16	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 20 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 5/2/94 COMPLETED 5/2/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 49.941 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 74.0 %
9. TOTAL DEPTH OF HOLE: 30.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'	Depth scale
49.9	.0					49.9		0
			(SM) SILTY SAND, gravelly, light yellowish brown some calcareous material.	67	1	SPLIT SPOON 48.4	22 / 33 / 41	
				100	2	" 46.9	22 / 40 / 65	2.5
				44	3	" 45.4	8 / 11 / 16	
				60	4	" 43.9	11 / 16 / 13	5
				100	5	" 42.4	8 / 12 / 21	7.5
				100	6	" 40.9	19 / 13 / 14	
40.4	9.5		(SW) WELL GRADED SAND, gravelly, olive-light olive gray.	100	7	" 39.4	12 / 20 / 19	10
				100	8	" 37.9	12 / 12 / 49	
				78	9	" 36.4	41 / 42 / 37	12.5
				100	10	" 34.9	22 / 21 / 14	15
				89	11	" 33.4	32 / 55 / 65	
				100	12	" 31.9	61 / 41 / 18	17.5
				100	13	" 30.4	15 / 16 / 12	
30.4	19.5		(SC) CLAYEY SAND, gravelly, yellowish brown.	100	14	" 28.9	7 / 7 / 7	20
				78	15	" 27.4	4 / 4 / 5	22.5
						(continued)		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-16

Hole No.CB-SAL-16

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 49.841 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"
27.4	22.5					27.4	
				56	16	- 25.9	4, 6, 8
24.4	25.5			58	17	- 24.4	10, 3, WH
22.9	27.0	CVM	CAVITY	0	18	- 22.9	0, 0, 0
			(CL) CLAY, silty, dark yellowish brown.	67	19	- 21.4	2, 4, 4
19.9	30.0			100	20	- 19.9	5, 8, 16

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)

LAB CLASSIFICATIONS
Elev. (Ft.) Wn LL PL PI
SM -42.2 6

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-SAL-16

Hole No.CB-COC-1

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=652,505 Y=57,923	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
4. HOLE NO. (As shown on drawing title and file number): CB-COC-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 20 undisturbed: 0
5. NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/12/84, COMPLETED 4/12/84
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 69.37 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 65 %
9. TOTAL DEPTH OF HOLE: 30.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'	
69.4	.0					69.4		0
			(SM) SILTY SAND, dark-yellowish brown some, gravel.	33	1	SPLIT SPOON 67.9	4 / 5 / 5	
				22	2	" 66.4	11 / 18 / 13	2.5
				33	3	" 64.9	8 / 9 / 9	
63.4	6.0			33	4	" 63.4	5 / 6 / 6	5
			(GM) SILTY GRAVEL and gravelly sand, grayish brown-gray.	18	5	" 61.9	9 / 18 / 29	7.5
				33	6	" 60.4	40 / 28 / 23	
				33	7	" 58.9	45 / 33 / 18	10
				78	8	" 57.4	8 / 8 / 8	
				78	9	" 55.9	38 / 52 / 29	12.5
54.4	15.0			89	10	" 54.4	18 / 13 / 13	15
			(SM) SILTY SAND, some gravel, dark yellowish brown.	89	11	" 52.9	16 / 20 / 21	
				33	12	" 51.4	35 / 24 / 19	17.5
				100	13	" 49.9	19 / 22 / 16	
48.4	21.0			56	14	" 48.4	24 / 31 / 26	20
			(SC) CLAYEY SAND, some silty sand, brown-grayish brown.	100	15	" 46.9	36 / 32 / 19	22.5
						(continued)		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-1

Hole No.CB-COC-2

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=553,488 Y=58,533	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
4. HOLE NO. (As shown on drawing title and file number): CB-COC-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
7. THICKNESS OF BURDEN: 0 Ft.	16. DATE HOLE: STARTED 4/13/94 COMPLETED 4/13/94
8. DEPTH DRILLED INTO ROCK: 0 Ft.	17. ELEVATION TOP OF HOLE: 73.8 Ft.
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 58.8 %
	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
73.8	.0					73.8	
			(SM) SILTY SAND, dark-yellowish brown, some gravel.	67	1	SPLIT SPOON 72.3	3 2 3
				89	2	" 70.8	5 5 6
69.3	4.5			100	3	" 69.3	6 4 6
			(GM) SILTY GRAVEL, some silty sand, dark yellowish brown-gray.	56	4	" 67.8	8 7 5
				56	5	" 66.3	2 17 35
				67	6	" 64.8	17 30 32
				44	7	" 63.3	24 18 18
				67	8	" 61.8	14 18 20
				56	9	" 60.3	18 18 20
				56	10	" 58.8	20 23 27
				44	11	" 57.3	14 20 17
55.8	18.0			33	12	" 55.8	26 25 21
			(ML) SILTS, some sand, grayish brown.	22	13	" 54.3	16 24 21
52.8	21.0			67	14	" 52.8	13 12 12
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2.0" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-2

Hole No.CB-COC-1

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE 69.37 Ft. | SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT | INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
46.9	22.5					46.9	
				100	16	" 45.4	19 / 30 / 35
				100	17	" 43.9	19 / 24 / 27
				100	18	" 42.4	19 / 28 / 29
				100	19	" 40.9	17 / 21 / 26
				100	20	" 39.4	10 / 16 / 32
39.4	30.0						

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0 SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SM	64.9	2	—	—	—
SM	48.9	3	—	—	—

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT | HOLE NUMBER: CB-COC-1

Hole No. CB-COC-3

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=554,438 Y=60,153	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
4. HOLE NO. (As shown on drawing title and file number): CB-COC-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
5. NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/14/94 COMPLETED 4/14/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 82.57 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 58.7 %
9. TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"
82.6	.0					82.6	
			(SM), SILTY SAND, dark-yellowish brown, some gravel.	56	1	SPLIT SPOON 81.1	3 / 5 / 5
				33	2	" 79.6	9 / 13 / 10
78.1	4.5			78	3	" 78.1	16 / 10 / 13
			(GM) SILTY GRAVEL, dark yellowish brown, some gray.	44	4	" 76.6	16 / 16 / 16
				78	5	" 75.1	16 / 21 / 13
				33	6	" 73.6	16 / 21 / 16
				44	7	" 72.1	16 / 26 / 26
				67	8	" 70.6	23 / 22 / 48
				44	9	" 69.1	22 / 15 / 13
				78	10	" 67.6	13 / 11 / 7
				100	11	" 66.1	11 / 16 / 14
			(SM) SILTY SAND, some gravel, dark yellowish brown.	56	12	" 64.6	18 / 22 / 34
				78	13	" 63.1	32 / 30 / 50
61.6	21.0			33	14	" 61.6	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-COC-3

Hole No.CB-COC-4

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=565,347 Y=58,731	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
4. HOLE NO. (As shown on drawing title and file number): CB-COC-4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 16 undisturbed: 0
5. NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/14/84 COMPLETED 4/14/84
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 80.14 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 54.6 %
9. TOTAL DEPTH OF HOLE: 24.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6 in.	
80.1	.0					80.1		0
			(SM) SILTY SAND, some gravel, dark-yellowish brown.	67	1	SPLIT SPOON 88.6	4 / 6 / 5	
				44	2	" 87.1	5 / 8 / 12	2.5
				22	3	" 85.6	6 / 7 / 5	
84.1	6.0			67	4	" 84.1	13 / 20 / 40	5
			(GM) SILTY GRAVEL, some silty sand, dark grayish brown-gray.	33	5	" 82.6	16 / 16 / 21	7.5
				33	6	" 81.1	14 / 13 / 25	
				33	7	" 79.6	21 / 48 / 14	10
				33	8	" 78.1	28 / 32 / 45	
77.1	13.0			33	9	" 76.6	28 / 36 / 40	12.5
			(ML) SILTS, sandy and some clayey material, dark yellowish brown.	33	10	" 75.1	12 / 17 / 20	15
				100	11	" 73.6	7 / 8 / 16	
				33	12	" 72.1	7 / 8 / 9	17.5
				100	13	" 70.6	12 / 8 / 12	
69.1	21.0			100	14	" 69.1	50 / 0 / 0	20
			(SM) SILTY SAND, brown-grayish brown.	100	15	" 67.6	100 / 0 / 0	22.5
						(continued)		

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-4

Hole No. CB-COC-4

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: 90.14 Ft.	SHEET 2 OF 2
PROJECT: RIO NIGUA PROJECT	INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
67.6	22.5					67.6	
				0			
66.1	24.0					66.1	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.)	

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SM	85.6	2	—	—	—
CL	73.6	4	37	21	16

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

[illegible] FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. [illegible] 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-4

Hole No. CB-COC-5

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1
1. PROJECT: RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT: See Remarks	
2. LOCATION (Coordinates or Station): X=556,127 Y=60,223		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45	
4. HOLE NO. (As shown on drawing title and file number): CB-COC-5		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 8 undisturbed: 0	
5. NAME OF DRILLER: NICOLAS ANDINO		14. TOTAL NUMBER OF CORE BOXES: 1	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED		15. ELEVATION GROUND WATER: NOT OBSERVED	
		16. DATE HOLE: STARTED 4/26/94 COMPLETED 4/26/94	
7. THICKNESS OF BURDEN: 0 Ft.		17. ELEVATION TOP OF HOLE: 95.946 Ft.	
8. DEPTH DRILLED INTO ROCK: 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING: 42.25 %	
9. TOTAL DEPTH OF HOLE: 12.0 Ft.		19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
95.9	.0					95.9	
			(SM) SILTY SAND, dark-yellowish brown some gravel.	80	1	SPLIT SPOON 94.4	2, 2, 3
				78	2	" 92.9	5, 6, 5
91.4	4.5			33	3	" 91.4	7, 14, 20
			(GM) SILTY GRAVEL, dark yellowish brown-gray.	33	4	" 89.9	17, 24, 52
				28	5	" 88.4	17, 22, 24
				33	6	" 86.9	12, 17, 24
				22	7	" 85.4	16, 24, 32
83.9	12.0			22	8	" 83.9	55, 74, 100
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0 SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.).	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
GM	88.4	2	--	--	--

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-5

Hole No.CB-COC-6

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2
1. PROJECT RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=556,974 Y=60,751		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NSL	
3. DRILLING AGENCY SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL BK-51	
4. HOLE NO. (As shown on drawing title and file number) CB-COC-6		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 14 undisturbed: 0	
5. NAME OF DRILLER PABLO ANDINO		14. TOTAL NUMBER OF CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER NOT OBSERVED	
		16. DATE HOLE STARTED 4/18/94 COMPLETED 4/18/94	
7. THICKNESS OF BURDEN 0 Ft.		17. ELEVATION TOP OF HOLE 102.897 Ft.	
8. DEPTH DRILLED INTO ROCK 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 55.27 %	
9. TOTAL DEPTH OF HOLE 21.0 Ft.		19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
102.9	.0					102.9	
			(SM) SILTY SAND, some gravel, dark-yellowish brown.	33	1	SPLIT SPOON 101.4	5 / 12 / 18
99.9	3.0			33	2	" 99.9	10 / 7 / 6
			(GM) SILTY GRAVEL, some silty sand, dark yellowish brown-gray.	56	3	" 98.4	3 / 3 / 9
				56	4	" 96.9	15 / 19 / 29
				44	5	" 95.4	13 / 16 / 15
				67	6	" 93.9	28 / 30 / 24
				44	7	" 92.4	17 / 24 / 32
				67	8	" 90.9	49 / 39 / 23
				78	9	" 89.4	18 / 15 / 12
				67	10	" 87.9	11 / 12 / 14
				56	11	" 86.4	19 / 30 / 27
				89	12	" 84.9	28 / 42 / 25
				44	13	" 83.4	24 / 43 / 21
81.9	21.0			44	14	" 81.9	18 / 21 / 50
						(continued)	

NB FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. AR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-6

Hole No.CB-COC-6

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 102.897 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
80.4	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev.(Ft.) Wn LL PL PI SM 80.4 2 — — —	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-6

Hole No. CB-COC-7

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=557,888 Y=61,258	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
4. HOLE NO. (As shown on drawing title and file number): CB-COC-7	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 18 undisturbed: 0
5. NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/19/94 COMPLETED 4/19/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 107.24 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 53.8 %
9. TOTAL DEPTH OF HOLE: 27.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
107.2	.0				107.2	
		(SM) SILTY SAND, some gravel, dark-yellowish brown.	33	1	SPLIT SPOON 105.7	5 11 10
			78	2	" 104.2	12 15 30
104.2	3.0	(GM) SILTY GRAVEL, yellowish brown-gray some clayey material below. elevation 93.7, some poorly graded gravel below elevation 90.7.	56	3	" 102.7	8 18 28
			17	4	" 101.2	30 15 17
			33	5	" 99.7	12 34 21
			89	6	" 98.2	60 100 0
			17	7	" 96.7	0 26 20
			33	8	" 95.2	60 13 11
			78	9	" 93.7	12 9 30
			100	10	" 92.2	28 50 0
			22	11	" 90.7	0 31 24
			67	12	" 89.2	21 16 16
89.2	18.0	(SM) SILTY SAND, gravelly, dark- yellowish brown.	56	13	" 87.7	17 18 24
			56	14	" 86.2	28 24 28
			44	15	" 84.7	31 26 26
					(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

NB FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. AR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-7

Hole No.CB-COC-7

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE 107.24 Ft.	SHEET 2 OF 2
PROJECT RIO NIGUA PROJECT	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6 in.
84.7	22.5					84.7	
				56	16	"	38 14 18
						83.2	
				78	17	"	10 25 61
						81.7	
				56	18	"	64
80.2	27.0					80.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.).	

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
GP	80.7	3	—	—	—

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-7

Hole No. CB-COC-8

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 2
PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
LOCATION (Coordinates or Station): X=658,398 Y=62,185	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: BK-51
HOLE NO. (As shown on drawing title and file number): CB-COC-8	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 14 undisturbed: 0
NAME OF DRILLER: PABLO ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/21/94 COMPLETED 4/21/94
THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 115.420 Ft.
DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 43.6 %
TOTAL DEPTH OF HOLE: 21.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
115.4	.0					115.4	
			(SM) SILTY SAND, some gravel, dark-yellowish brown.	33	1	SPLIT SPOON 113.9	2 / 3 / 3
				56	2	" 112.4	5 / 10 / 27
112.4	3.0		(GM) SILTY GRAVEL, dark yellowish brown-gray, some silty sand below elevation 109.4.	44	3	" 110.9	12 / 15 / 28
				56	4	" 109.4	10 / 48 / 17
				56	5	" 107.9	17 / 18 / 19
				33	6	" 106.4	13 / 7 / 7
				22	7	" 104.9	11 / 15 / 16
				33	8	" 103.4	11 / 13 / 8
				44	9	" 101.9	10 / 14 / 18
				78	10	" 100.4	30 / 24 / 31
				56	11	" 98.9	30 / 42 / 49
				28	12	" 97.4	16 / 18 / 11
				28	13	" 95.9	20 / 46 / 38
				44	14	" 94.4	18 / 18 / 22
94.4	21.0						

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

(continued)

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. JA 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-COC-8

Hole No.CB-COC-8

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE	SHEET 2 OF 2
115.420 Ft.	

PROJECT	INSTALLATION
RIO NIGUA PROJECT	Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
92.9	22.5						
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8" I.D. X 2.0" O.D.)	
						LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SM 107.8 1 -- -- --	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-8

Hole No.CB-COC-9

DRILLING LOG DIVISION South Atlantic	INSTALLATION Jacksonville District — SHEET 1 OF 2
1. PROJECT RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=558,897 Y=63,022	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL CME-45
4. HOLE NO. (As shown on drawing title and file number) CB-COC-9	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 20 undisturbed: 0
5. NAME OF DRILLER NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES 19
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER NOT OBSERVED
	16. DATE HOLE STARTED 4/45/94 COMPLETED 4/45/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 125.141 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 65 %
9. TOTAL DEPTH OF HOLE 28.0 Ft.	19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
125.1	.0				125.1	
		(SM) SILTY SAND, some gravel, dark-yellowish brown.	56	1	SPLIT SPOON 123.6	4 / 4 / 4
122.1	3.0		67	2	" 122.1	4 / 4 / 6
		(GM) SILTY GRAVEL, grayish brown-gray.	67	3	" 120.6	10 / 18 / 21
			78	4	" 119.1	18 / 18 / 24
			56	5	" 117.6	18 / 24 / 28
			33	6	" 116.1	64 / 0 / 0
			44	7	" 114.6	11 / 11 / 21
			100	8	" 113.1	50 / 0 / 0
			NR	9	" 111.6	58 / 0 / 0
			NR	10	" 110.1	55 / 0 / 0
			NR	11	" 108.6	60 / 0 / 8
			56	12	" 107.1	12 / 14 / 21
			22	13	" 105.6	34 / 42 / 36
104.1	21.0		78	14	" 104.1	42 / 48 / 32
		(GM) SILTY GRAVEL, some clayey material, dark yellowish brown.	67	15	" 102.6	21 / 18 / 10
					(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-9

Hole No.CB-COC-9

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: 125.141 Ft.
SHEET 2 OF 2

PROJECT: RIO NIGUA PROJECT
INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
102.6	22.5					102.6	
				56	16		28 / 36 / 26
						101.1	
				67	17		46 / 60 / 26
						99.6	
				67	18		46 / 70 / 33
						98.1	
				60	19		75 / 0 / 0
96.6	28.5					96.6	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)	
						LAB CLASSIFICATIONS CLASS Elev.(Ft.) Wn LL PL PI GM 114.6 3	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-9

Hole No.CB-COC-10

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District — SHEET 1 OF 1
1. PROJECT RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=558,389 Y=63,884	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL CME-45
4. HOLE NO. (As shown on drawing title and file number) CB-COC-10	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 9 undisturbed: 0
5. NAME OF DRILLER NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER NOT OBSERVED
7. THICKNESS OF BURDEN 0 Ft.	16. DATE HOLE STARTED 4/28/94 COMPLETED 4/28/94
8. DEPTH DRILLED INTO ROCK 0 Ft.	17. ELEVATION TOP OF HOLE 131.850 Ft.
9. TOTAL DEPTH OF HOLE 13.5 Ft.	18. TOTAL CORE RECOVERY FOR BORING 29.5 %
	19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"
131.9	.0				131.9	
		(SM) SILTY SAND, some gravel, dark-yellowish brown.	28	1	SPLIT SPOON 130.4	5 8 15
			22	2	" 128.9	20 18 18
128.9	3.0	(GM) SILTY GRAVEL, dark yellowish brown-gray.	330	3	" 127.3	26 27 43
			28	4	" 125.8	21 22 19
			28	5	" 124.3	19 12 4
			33	6	" 122.8	10 10 21
			38	7	" 121.3	24 31 41
121.3	10.5	(SM) SILTY SAND, some gravel, dark yellowish brown.	28	8	" 119.8	52 100 0
118.3	13.5		28	9	" 118.3	100 0 0

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
GM	125.8	1	--	--	--

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT RIO NIGUA PROJECT — HOLE NUMBER CB-COC-10

Hole No.CB-COC-11

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT RIO NIGUA PROJECT		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=558,907 Y=64,777		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY SUELOS INC.		12. MANUFACTURER'S DESIGNATION OF DRILL CME-45	
4. HOLE NO. (As shown on drawing title and file number) CB-COC-11		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 9 undisturbed: 0	
5. NAME OF DRILLER NICOLAS ANDINO		14. TOTAL NUMBER OF CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER NOT OBSERVED	
		16. DATE HOLE STARTED 4/25/94 COMPLETED 4/25/94	
7. THICKNESS OF BURDEN 0 Ft.		17. ELEVATION TOP OF HOLE 139.905 Ft.	
8. DEPTH DRILLED INTO ROCK 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 23.4 %	
9. TOTAL DEPTH OF HOLE 13.5 Ft.		19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/.5'
139.9	.0					139.9	
			(SM) SILTY SAND, some gravel, dark-yellowish brown.	44	1	SPLIT SPOON 138.4	5 / 8 / 11
136.9	3.0			22	2	" 136.9	16 / 19 / 21
			(SW) WELL GRADED SAND, dark yellowish brown.	28	3	" 135.4	43 / 100 / 0
				33	4	" 133.9	15 / 11 / 10
				22	5	" 132.4	10 / 8 / 12
				11	6	" 130.9	35 / 100 / 0
				26	7	" 129.4	15 / 50 / 100
				17	8	" 127.9	47 / 51 / 32
126.4	13.5			11	9	" 126.4	53 / 60 / 100
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2" O.D.) LAB CLASSIFICATIONS CLASS Elev. (Ft.) Wn LL PL PI SW 127.4 3	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

SAJ FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-11

Hole No.CB-COC-12

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=580,392 Y=65,558	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-COC-12	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 10 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/25/94 COMPLETED 4/25/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 143.828 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 32.0 %
9. TOTAL DEPTH OF HOLE: 15.0 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ 6"
143.8	.0	(SM) SILTY SAND, some gravel, dark-yellowish brown.	22	1	143.8 SPLIT SPOON 142.3	9, 17, 11
			33	2	" 140.8	15, 17, 15
			33	3	" 139.3	10, 18, 20
139.3	4.5	(GM) SILTY GRAVEL, dark yellowish brown.	28	4	" 137.8	12, 33, 21
			38	5	" 136.3	20, 14, 11
			44	6	" 134.8	12, 14, 8
			22	7	" 133.3	13, 15, 22
			33	8	" 131.8	34, 43, 52
			17	9	" 130.3	37, 41, 70
			50	10	" 128.8	52, 100
128.8	15.0	Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2.0" O.D.)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
SM	139.3	4			

SAJ FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. JUN 71

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: CB-COC-12

Hole No.CB-COC-13

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1

1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=560,858 Y=66,430	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-45
4. HOLE NO. (As shown on drawing title and file number): CB-COC-13	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 10 undisturbed: 0
5. NAME OF DRILLER: NICOLAS ANDINO	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4/25/84, COMPLETED 4/25/84
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: 154.40 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 45.0 %
9. TOTAL DEPTH OF HOLE: 13.5 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon	BLOWS/ .5'
154.4	.0					154.4	
			(SM) SILTY SAND, some gravel, dark-yellowish brown.	44	1	SPLIT SPOON 152.9	4 / 19 / 28
				33	2	" 151.4	25 / 14 / 13
151.4	3.0		(GM) SILTY GRAVEL, dark yellowish brown.	56	3	" 149.9	10 / 13 / 14
				67	4	" 148.4	11 / 11 / 18
				67	5	" 146.9	25 / 20 / 20
				28	6	" 145.4	20 / 26 / 24
				44	7	" 143.9	24 / 14 / 28
				28	8	" 142.4	19 / 25 / 35
				28	9	" 140.9	40 / 52 / 100
					10	" 139.4	100
139.4	15.0						

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0" SPLIT SPOON (1-3/8 I.D. X 2.0" O.D.)

LAB CLASSIFICATIONS

CLASS	Elev. (Ft.)	Wn	LL	PL	PI
GM	105.4	4			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	CB-COC-13

Hole No.TP-SAL-1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL FORD 5500
4. HOLE NO. (As shown on drawing title and file number) TP-SAL-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 2 undisturbed: 0
5. NAME OF DRILLER RAUL CARTAGENA	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER NOT OBSERVED
	16. DATE HOLE STARTED 4-14-94 COMPLETED 4-14-94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING NA
9. TOTAL DEPTH OF HOLE 8.5 Ft.	19. SIGNATURE OF GEOLOGIST ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon
n/a	.0					
			TOP SOIL			
			(SM) SILTY SAND, some gravel, pale yellow, some white rock fragments, some caliche.		1	
	3.0		(GM) SILTY GRAVEL AND ROCK FRAGMENTS, calcareous, pale yellow, white. some recrystalized limestone, hard.		2	
	8.5					
			Soils are field visually classified in accordance with the Unified Soils Classification System.			LAB CLASSIFICATION CLASS ELEV. (Ft.) WN LL PL PI [illegible] 6

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. AR 71

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	TP-SAL-1

Hole No. TP-SAL-2

SHEET 1 OF 1

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station):	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: TELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: FORD 5500
4. HOLE NO. (As shown on drawing title and file number): TP-SAL-2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 2 undisturbed: 0
5. NAME OF DRILLER: RAUL CARTAGENA	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4-14-94 COMPLETED 4-14-94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE:
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: NA
9. TOTAL DEPTH OF HOLE: 5.6 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon
n/a	.0					
			TOP SOIL			
			(GM) SILTY GRAVEL yellowish brown, some silty sand, some weathering stains, some volcanic rock fragments.		1	-
	3.0		(SM) SILTY SAND, some gravel, yellowish brown, weathered volcanic rock, hard.		2	-
	5.5					-
			Soils are field visually classified in accordance with the Unified Soils Classification System.			LAB CLASSIFICATION CLASS ELEV. (Ft.) WN LL PL PI [illegible] 4

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	TP-SAL-2

Hole No. TP-SAL-3

DRILLING LOG

Field	Entry	Field	Entry
DIVISION	South Atlantic	INSTALLATION	Jacksonville District — SHEET 1 OF 1
1. PROJECT	RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT	See Remarks
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
3. DRILLING AGENCY	SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL	FORD 5500
4. HOLE NO. (As shown on drawing title and file number)	TP-SAL-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	disturbed: 2 undisturbed: 0
5. NAME OF DRILLER	RAUL CARTAGENA	14. TOTAL NUMBER OF CORE BOXES	1
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED	15. ELEVATION GROUND WATER	NOT OBSERVED
		16. DATE HOLE	STARTED 4-14-94 COMPLETED 4-14-94
7. THICKNESS OF BURDEN	0 Ft.	17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK	0 Ft.	18. TOTAL CORE RECOVERY FOR BORING	NA
9. TOTAL DEPTH OF HOLE	5.6 Ft.	19. SIGNATURE OF GEOLOGIST	ARNALDO HERNANDEZ

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon
n/a	.0					
			TOP SOIL			
			(SM) SILTY SAND, reddish brown, some yellowish brown, trace gravel.		1	
	3.0		(SM) SILTY SAND, some gravel, yellowish brown, weathered volcanic rock, hard.		2	
	5.5					
			Soils are field visually classified in accordance with the Unified Soils Classification System.			LAB CLASSIFICATION CLASS ELEV. (Ft.) WN LL PL PI (SM) 3

Scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
RIO NIGUA PROJECT	TP-SAL-3

Hole No.TP-SAL-4

DRILLING LOG — DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: RIO NIGUA PROJECT	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: SUELOS INC.	12. MANUFACTURER'S DESIGNATION OF DRILL: FORD 5500
4. HOLE NO. (As shown on drawing title and file number): TP-SAL-4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 2 undisturbed: 0
5. NAME OF DRILLER: RAUL CARTAGENA	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: NOT OBSERVED
	16. DATE HOLE: STARTED 4-14-94, COMPLETED 4-14-94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: NA
9. TOTAL DEPTH OF HOLE: 7.5 Ft.	19. SIGNATURE OF GEOLOGIST: ARNALDO HERNANDEZ

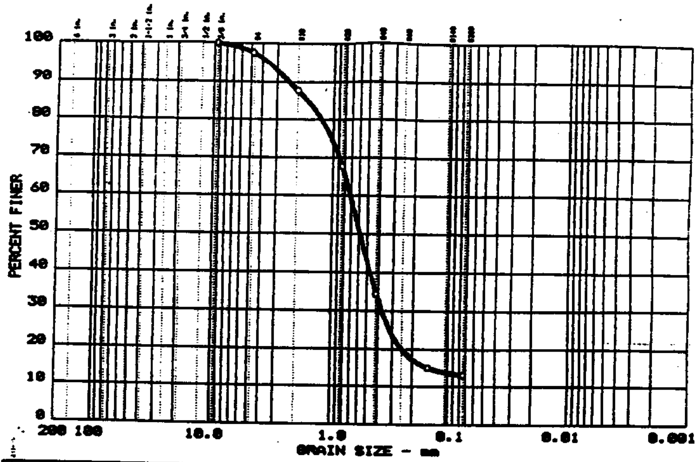
ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Split Spoon
n/a	0		TOP SOIL			
			(ML) SILT, some sand, some roots, weathering stains dark brown.		1	
	3.0		(SM) SILTY GRAVEL AND ROCK FRAGMENTS, calcareous, pale yellow, white, some recrystalized limestone, hard.		2	
					3	
	7.5		Soils are field visually classified in accordance with the Unified Soils Classification System.			LAB CLASSIFICATION CLASS (SM) ELEV. (Ft.) Wn 10 LL PL PI

Scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: RIO NIGUA PROJECT — HOLE NUMBER: TP-SAL-4

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	16	0.0	2.4	84.5	13.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	1.64	0.71	0.50	0.374	0.1488			

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-1, SAMPLE 4

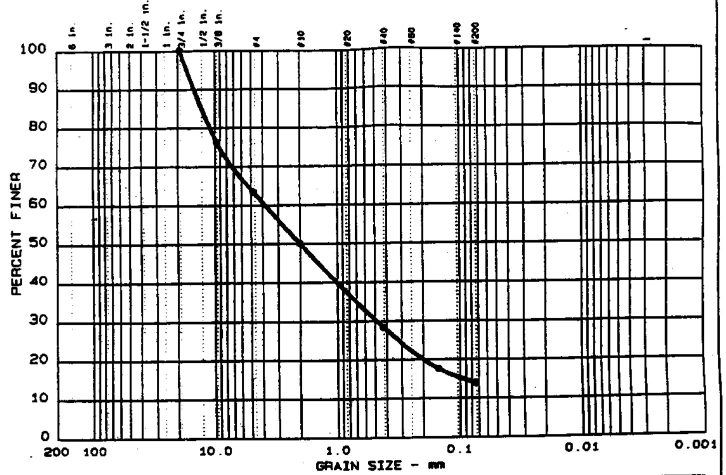
Date: 9-7-1994

Remarks:
BORING CB-SAL-1
SAMPLE No. 4

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	36.6	49.5	13.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			12.69	3.79	1.99	0.477	0.0930			

MATERIAL DESCRIPTION	USCS	AASHTO
● SILTY SAND, SOME GRAVEL		

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
● Location: BORING CB-SAL-2, SAMPLE No. 5

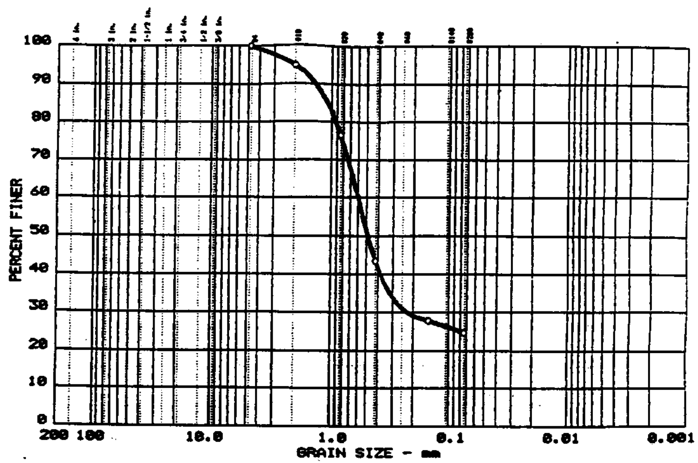
Date: 9-17-94

Remarks:
RIO NIGUA
BORING CB-SAL-2
SAMPLE No.5

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	5	0.0	0.0	75.3	24.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	1.08	0.60	0.49	0.223				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR.CB-SAL-3 ,SAMPLE 11

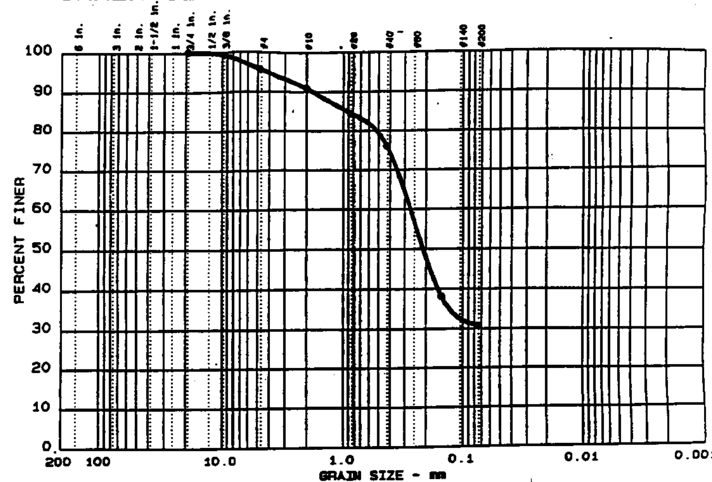
Date: 9-7-1994

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-3
SAMPLE No. 11

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	4.4	65.0	30.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.91	0.27	0.21					

MATERIAL DESCRIPTION	USCS	AASHTO
● SILTY SAND, SOME GRAVEL	SM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
● Location: BORING CB-SAL-4, SAMPLE No. 7

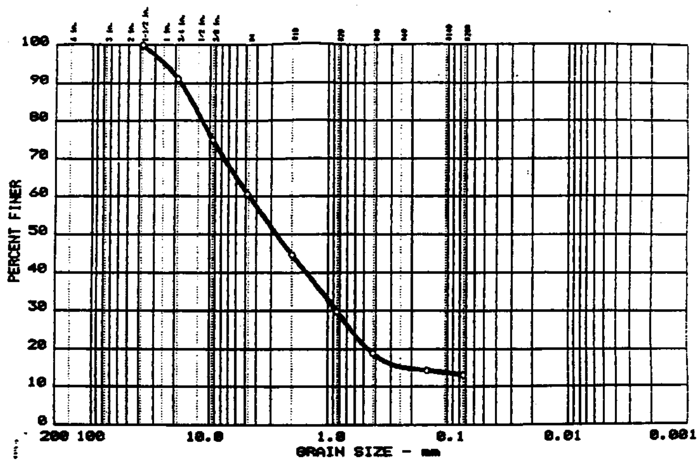
Date: 11-29-94

Remarks:
BORING CB-SAL-4
SAMPLE No.7

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	10	0.0	39.3	47.6	13.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	NP	NP	14.29	4.57	2.69	0.841	0.2291			

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	A-1-a

Project No.:
Project: RIO NIGUA,SALINAS P.R.
o Location: BOR.CB-SAL-5,SAMPLE 10

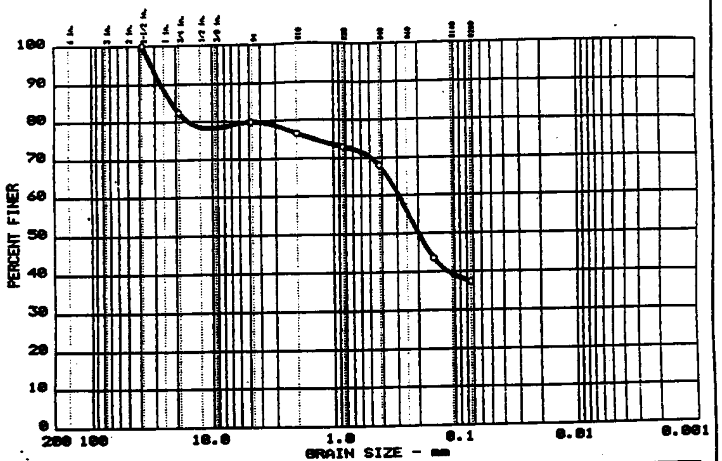
Date: 9-7-1994

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-5
SAMPLE No. 10

Figure No.1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	99	0.0	20.2	42.5	37.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	NP	NP	21.85	0.29	0.20					

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	A-4

Project No.:
Project: RIO NIGUA,SALINAS P.R.
o Location: BOR.CB-SAL-6 ,SAMPLE 4

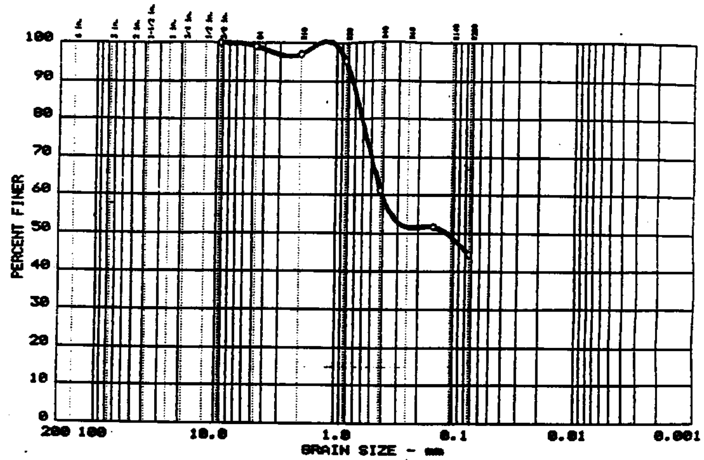
Date: 9-7-1994

Remarks:
BORING CB-SAL-6
SAMPLE No. 4

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No.1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	7	0.0	0.9	54.7	44.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	0.67	0.41	0.11					

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-4

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR.CB-SAL-7 , SAMPLE 13

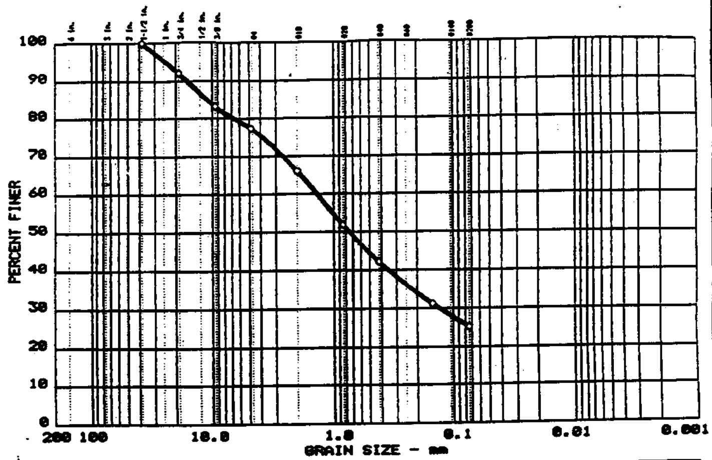
Date: 9-7-1994

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-7
SAMPLE No. 13

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	22.7	52.1	25.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	NP	NP	11.89	1.38	0.74	0.129				

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
o Location: BOR. CB-SAL-8, SAMPLE 5

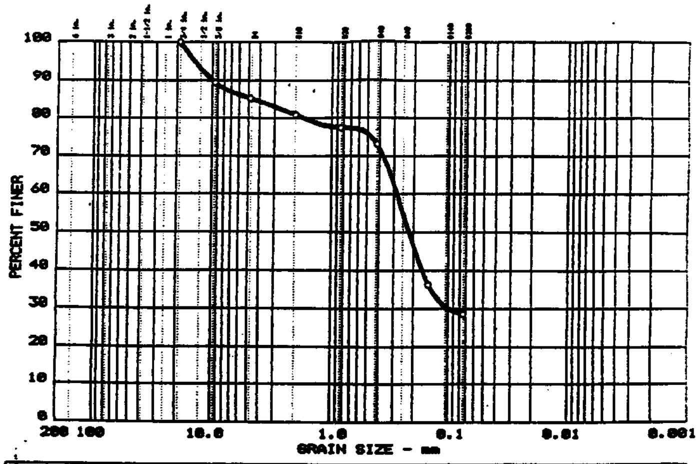
Date: 9-7-1994

Remarks:
BORING CB-SAL-8
SAMPLE No. 5

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	12	0.0	14.0	56.6	28.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	4.52	0.28	0.22	0.100				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-2-4

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-10, SAMPLE 6

Date: 9-7-1994

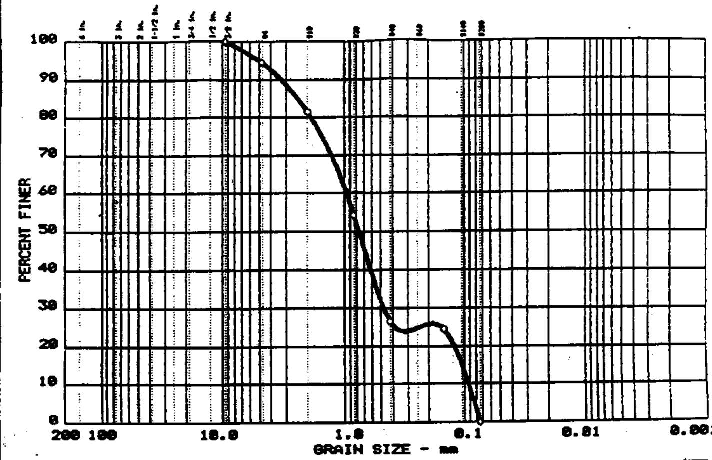
GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-10

SAMPLE No. 6

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
o	9	0.0	5.5	94.5	0.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	NP	NP	2.37	0.96	0.76	0.475	0.1051	0.0926	2.53	10.4

MATERIAL DESCRIPTION	USCS	AASHTO
o WELL GRADED SAND.	SW	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
o Location: BOR.CB-SAL-9 ,SAMPLE 11

Date: 9-7-1994

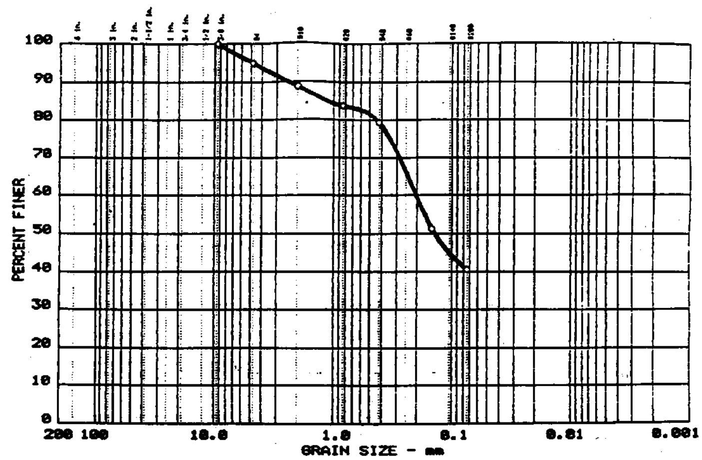
Remarks:
BORING CB-SAL-9

SAMPLE No. 11

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	-2	0.0	5.1	54.4	40.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	44	18	1.12	0.20	0.14					

MATERIAL DESCRIPTION	USCS	AASHTO
o CLAYEY SAND	SC	A-7-6(4)

Project No.:
Project: RIO NIGUA, SALINAS P.R.
o Location: BOR. CB-SAL-11, SAMPLE 7

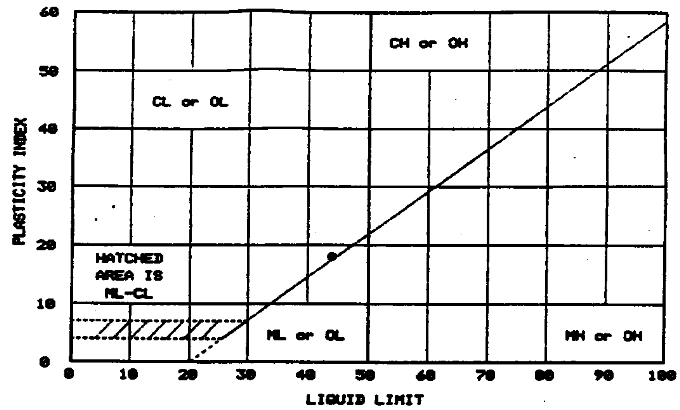
Date: 9/7/1994

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-11
SAMPLE No. 7

Figure No. 2

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	USCS	AASHTO
●	BOR.CB-SAL-11, SAMPLE 7 CLAYEY SAND	44	26	18	40.5	SC	A-7-6(4)

Project No.:
Project: RIO NIGUA

Client: USACE
Location: SALINAS P.R.

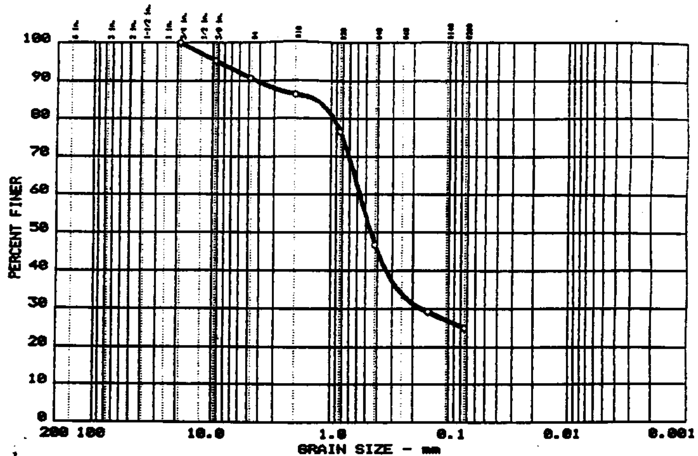
Date: 9/7/1994

LIQUID AND PLASTIC LIMITS TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-11
SAMPLE No. 7

Fig. No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	15	0.0	9.3	65.7	25.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	1.36	0.57	0.45	0.167				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-12, SAMPLE 5

Date: 9-7-1994

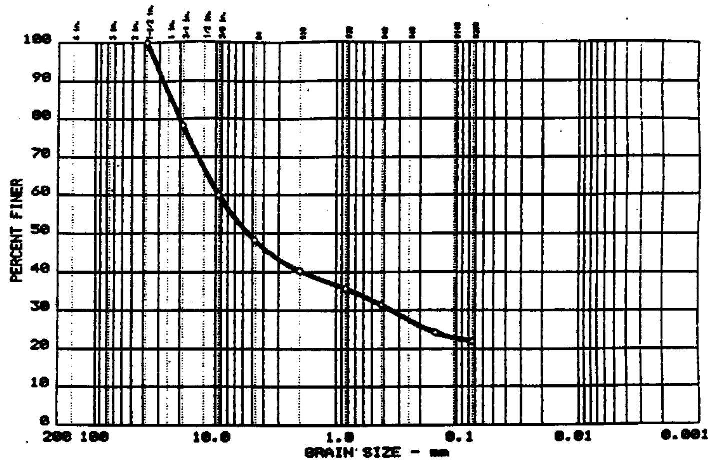
Remarks:
BORING CB-SAL-12

SAMPLE No. 5

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	14	0.0	51.7	26.4	21.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	23.71	9.44	5.37	0.347				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY GRAVEL	GM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-13, SAMPLE 4

Date: 9-7-1994

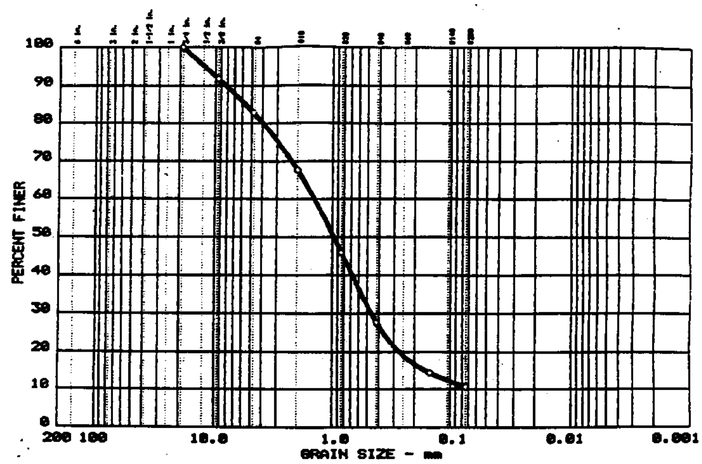
GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-13

SAMPLE No. 4

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	13	0.0	17.2	72.1	10.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	5.56	1.43	0.97	0.462	0.1622			

MATERIAL DESCRIPTION	USCS	AASHTO
○ POORLY GRADED SILTY SAND	SP-SM	A-1-a

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-14, SAMPLE 11

Date: 9-7-1994

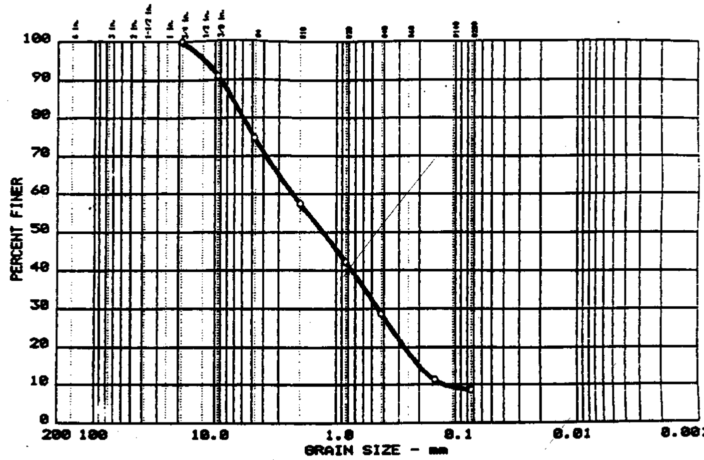
Remarks:
BORING CB-SAL-14

SAMPLE No. 11

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	11	0.0	25.3	66.0	8.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	7.24	2.29	1.29	0.446	0.1993	0.1215	0.72	18.8

MATERIAL DESCRIPTION	USCS	AASHTO
○ POORLY GRADED SILTY SAND.	SP-SM	A-1-b

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR. CB-SAL-15, SAMPLE 8

Date: 9-7-1994

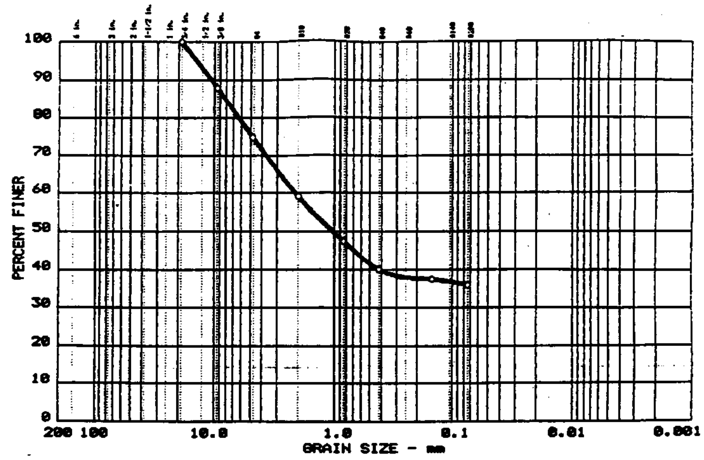
GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-SAL-15

SAMPLE No. 8

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75	% GRAVEL	% SAND	% SILT	% CLAY
○	.4	0.0	25.2	38.9	35.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	8.13	2.09	1.02					

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	A-4

Project No.:
Project: RIO NIGUA, SALINAS P.R.
○ Location: BOR.CB-SAL-16, SAMPLE 5

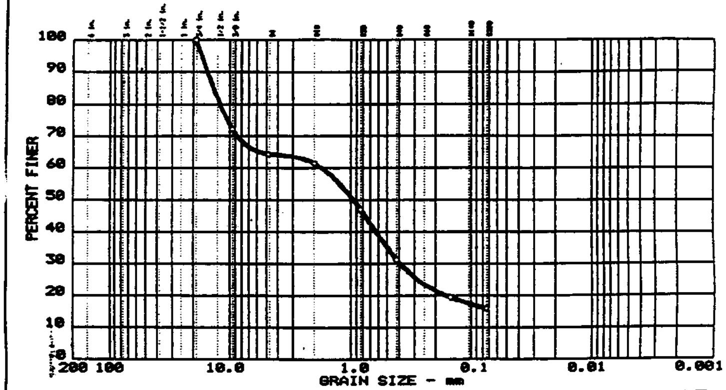
Date: 9-7-1994

Remarks:
BORING CB-SAL-16
SAMPLE No. 5

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o 17	0.0	35.7	48.3	16.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o	NP	NP	13.65	1.70	0.95	0.389				

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	

Project No.:
Project: RIO NIGUA PROJECT, SALINAS, PUERTO RICO
o Location: CB-COC-1 SAMPLE # 1

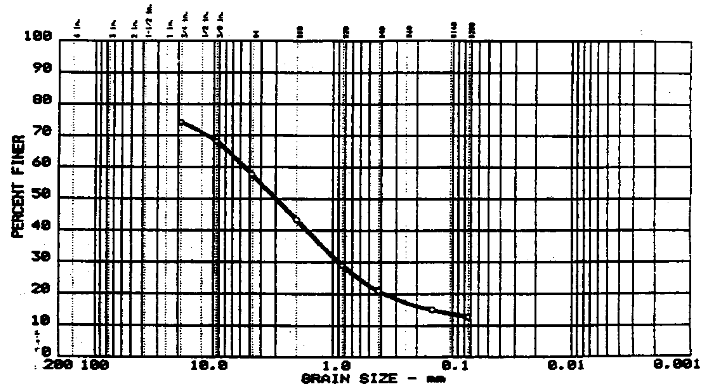
Date: 9-24-94

Remarks:
BORING CB-COC-1
SAMPLE NO. 3

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	42.3	44.9	12.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			19.05	5.43	2.95	0.891	0.1479			

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	

Project No.:
Project: RIO NIGUA SALINAS, PUERTO RICO
o Location: BORING CB-COC-1 SAMPLE # 13

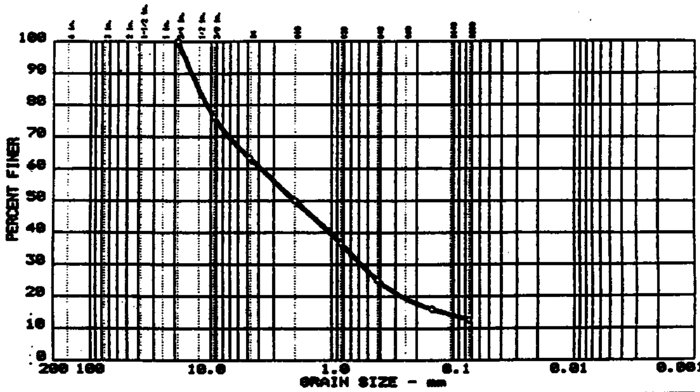
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-1
SAMPLE NO. 13

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	36.6	50.6	12.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			12.69	3.79	1.99	0.567	0.1171			

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND, YELLOWISH BROWN	SM	

Project No.:
Project: RIO NIGUA PROJECT, SALINAS, PUERTO RICO
o Location: BORING CB-COC-2 SAMPLE # 3

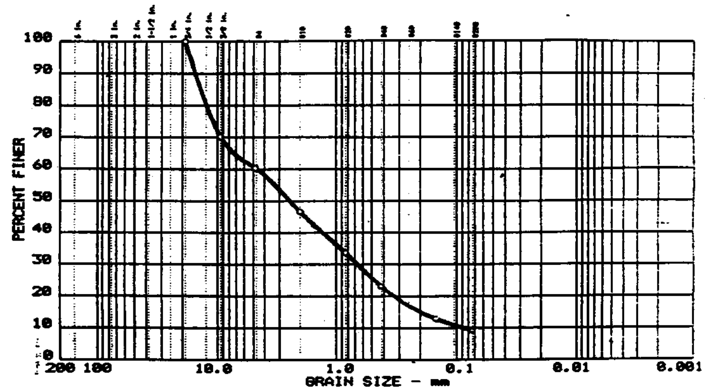
Date: 9-24-94

Remarks:
BORING CB-COC-2
SAMPLE NO. 3

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No.1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	39.5	51.2	9.3	-

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			14.03	4.54	2.41	0.656	0.1959	0.0836	1.14	54.3

MATERIAL DESCRIPTION	USCS	AASHTO
o WELL GRADED SILTY SAND	SW-SM	

Project No.:
Project: RIO NIGUA SALINAS, PUERTO RICO
o Location: BORING CB-COC-4 SAMPLE # 4

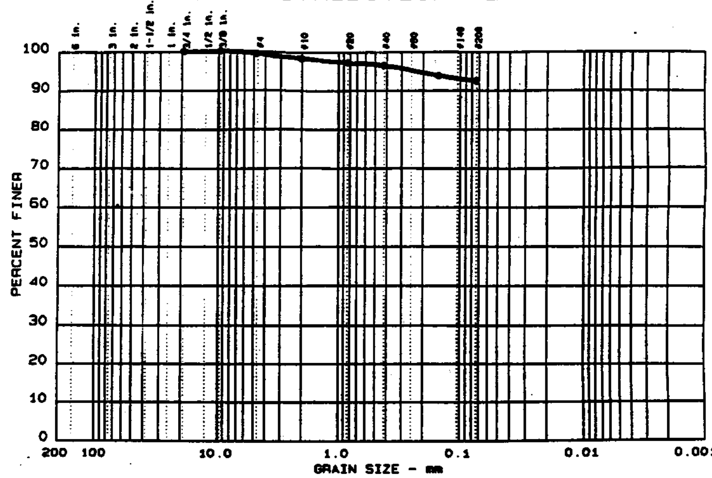
Date: 9-24-94

Remarks:
BORING CB-COC-4
SAMPLE NO. 4

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.8	6.7	92.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	37	16								

MATERIAL DESCRIPTION	USCS	AASHTO
● CLAY, SOME SAND.	CL	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
● Location: BORING CB-COC-4, SAMPLE No. 11

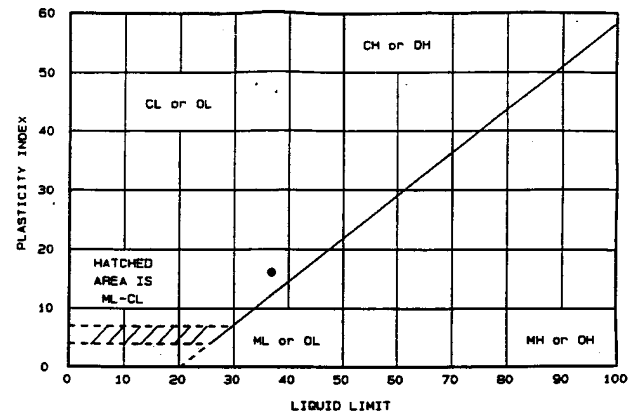
Date: 9-17-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
RIO NIGUA
BORING CB-COC-4
SAMPLE No. 11

Figure No. 1

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	RIO NIGUA, SALINAS, P.R.	37	21	16	92.5	CL, Lean clay

Project No.:
Project: RIO NIGUA

Client USACE
Location: BORING CB-COC-4, SAMPLE No. 11

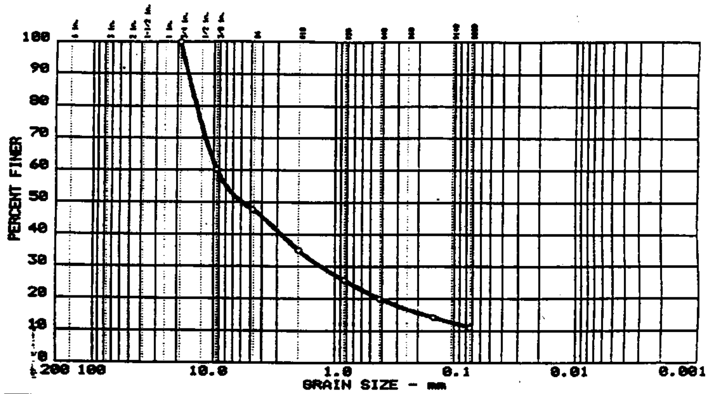
Date: 11-19-94

Remarks:
RIO NIGUA
BORING CB-COC-4
SAMPLE No. 11

LIQUID AND PLASTIC LIMITS TEST REPORT
SUELOS INC.

Fig. No. 2

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	52.2	36.7	11.1	-- -

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			15.19	9.44	5.82	1.288	0.1660			

	MATERIAL DESCRIPTION	USCS	AASHTO
o	POORLY GRADED SILTY GRAVEL	GP-GM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-5 SAMPLE # 5

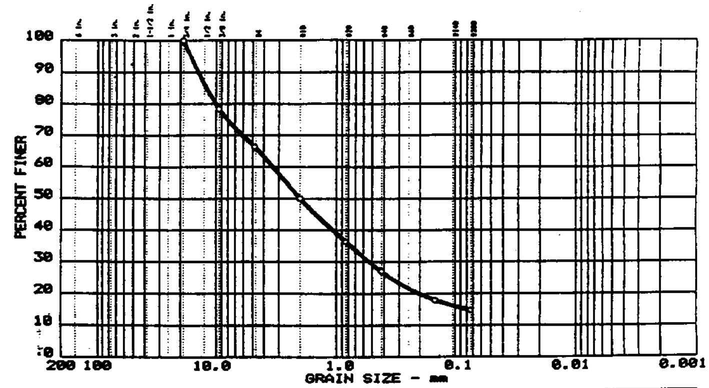
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-5
SAMPLE NO. 5

Figure No.1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	33.7	51.5	14.8	-- -

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			12.15	3.35	1.97	0.524	0.0740			

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	

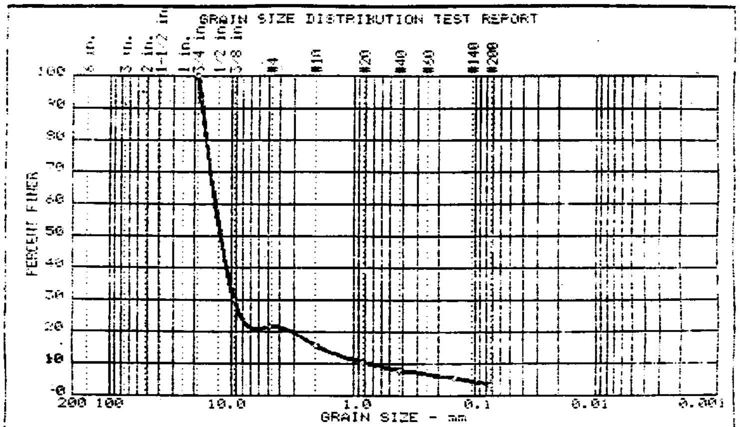
Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-6 SAMPLE # 9

Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-6
SAMPLE NO. 9

Figure No. 1

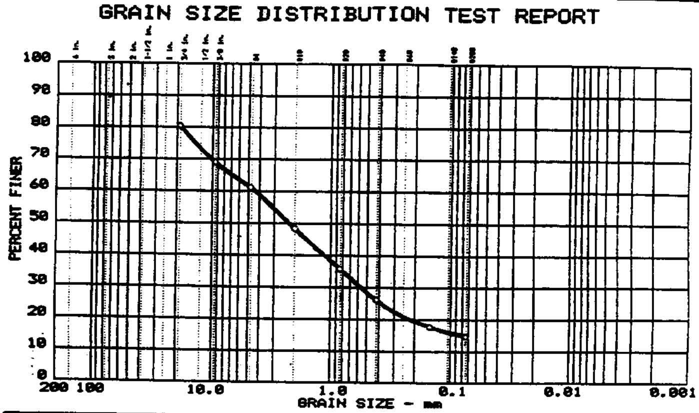


	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	78.4	18.3	3.3	

LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
[illegible]	[illegible]	[illegible]	13.56	11.52	9.50	[illegible]	[illegible]	[illegible]	[illegible]

BORING CB-COC-7 SAMPLE No. 11

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	38.8	46.4	14.8	-- -

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			19.05	4.31	2.21	0.556	0.0741			

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY SAND	SM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-8 SAMPLE No. 5

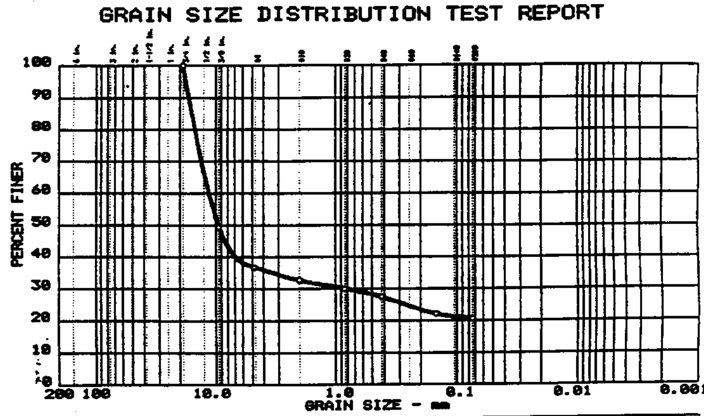
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-8
SAMPLE NO. 5

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	63.2	16.1	20.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			15.98	11.49	9.63	0.810				

MATERIAL DESCRIPTION	USCS	AASHTO
o WELL GRADED SILTY SAND	GM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-9 SAMPLE No. 7

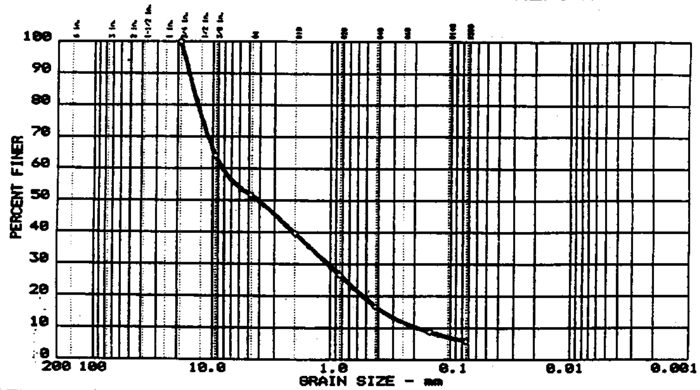
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORIH CB-COC-9
SAMPLE NO. 7

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	48.3	45.9	5.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			14.79	8.31	4.12	1.034	0.3544	0.1860	0.69	44.7

MATERIAL DESCRIPTION	USCS	AASHTO
o POORLLY GRADED SILTY GRAVEL	GP-GM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-10 SAMPLE No. 4

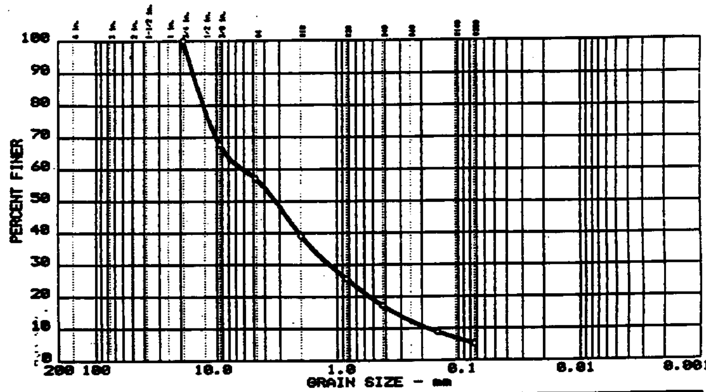
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-10
SAMPLE NO. 4

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	42.8	52.0	5.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			14.42	6.01	3.23	1.159	0.3304	0.1774	1.26	33.9

MATERIAL DESCRIPTION	USCS	AASHTO
o WELL GRADED SILTY SAND	SW-SM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
o Location: BORING CB-COC-11 SAMPLE No. 8

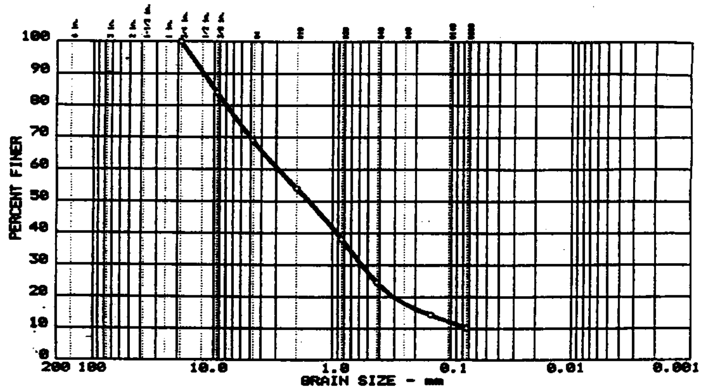
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-11
SAMPLE NO. 8

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	17	0.0	31.0	58.8	10.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			9.86	2.84	1.56	0.561	0.1618			

MATERIAL DESCRIPTION	USCS	AASHTO
○ POORLY GRADED SILTY SAND	SP-SM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO
○ Location: BORING CB-COC-12 SAMPLE No. 3

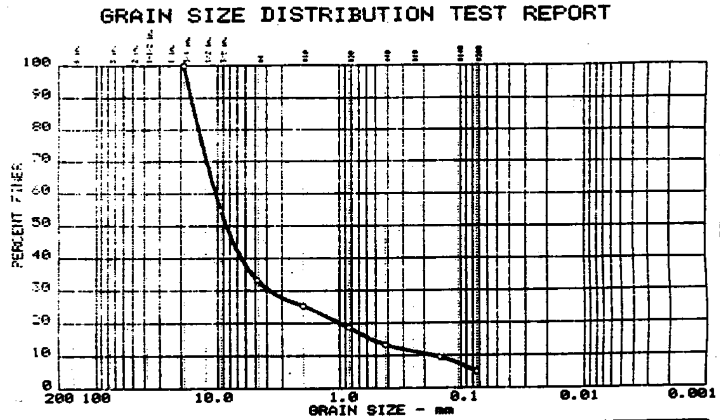
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-12
SAMPLE NO. 3

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
17	0.0	66.8	28.1	5.1	-

LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
		15.45	10.48	8.57	3.741	0.5284	0.1671	7.99	62.7

MATERIAL DESCRIPTION	USCS	AASHTO
POORLY GRADED SILTY GRAVEL	GP-GM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
Location: BORING CB-COC-13 SAMPLE No.8

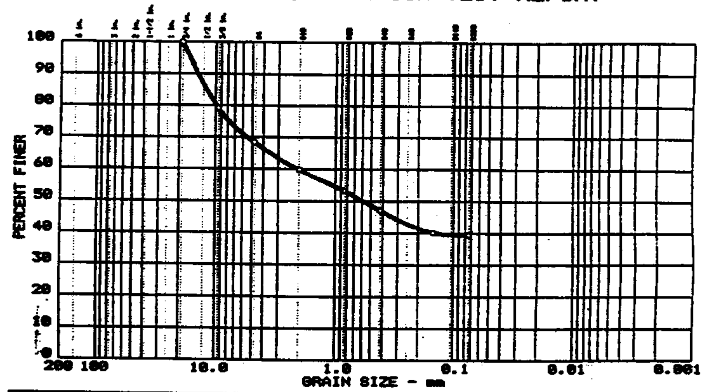
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
BORING CB-COC-13
SAMPLE NO. 8

Figure No.1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	10	0.0	31.6	20.9	39.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			11.89	2.04	0.57					

MATERIAL DESCRIPTION	USCS	AASHTO
o SILTY GRAVEL	GM	

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
o Location: TEST PIT TP-SAL-1, SAMPLE No. 1

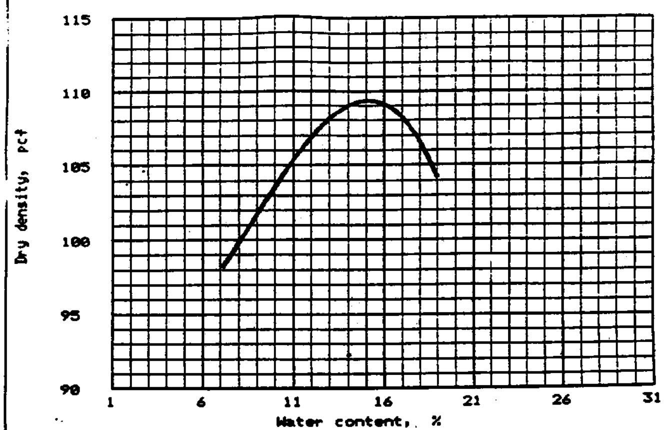
Date: 9-24-94

Remarks:
TEST-PIT TP-SAL-1
SAMPLE NO. 1

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

PROCTOR TEST REPORT



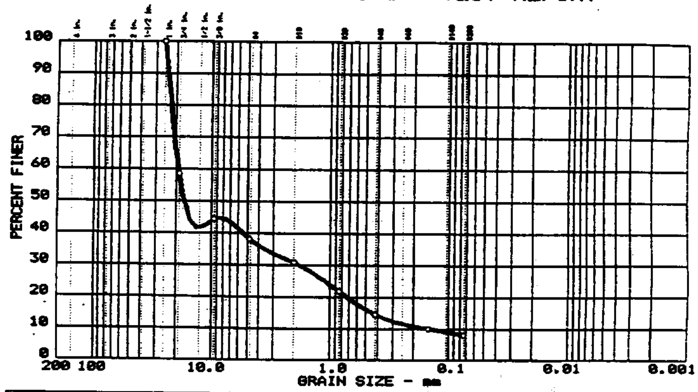
"Standard" Proctor, ASTM D 698, Method C

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	GM		6 %				68.4 %	39.5 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 15.2 % Maximum dry density = 109.3 pcf	SILTY GRAVEL WITH SAND,

Project No.: Project: RIO NIGUA, SALINAS, PUERTO RICO. Location: TEST PIT TP-SAL-1, SAMPLE No. 1 Date: 9-24-94	Remarks: TEST PIT TP-SAL-1 SAMPLE NO. 1
PROCTOR TEST REPORT SUELOS INC.	Figure No. 3

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
o	17	0.0	61.8	30.1	8.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			23.15	19.30	17.24	1.764	0.4330	0.1323	1.22	145.9

MATERIAL DESCRIPTION	USCS	AASHTO
o WELL GRADED SILTY GRAVEL	GW-GM	

Project No.:
Project: RIO NIGUA PROJECT, SALINAS PUERTO RICO
o Location: TEST PIT TP-SAL-2, SAMPLE No. 2

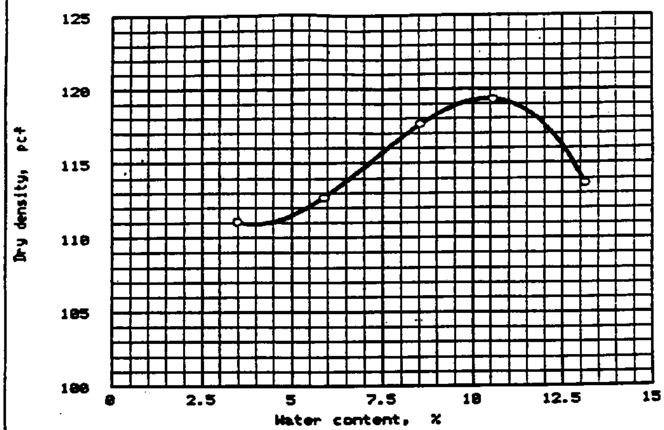
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
TEST PIT TP-SAL-2
SAMPLE NO. 2

Figure No. 1

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method C

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	GW-GM	A-2-4					38.2 %	8-15 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 10.4 % Maximum dry density = 119.3 pcf	WELL GRADED SILTY GRAVEL

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
Location: TEST PIT TP-SAL-2, SAMPLE No. 2

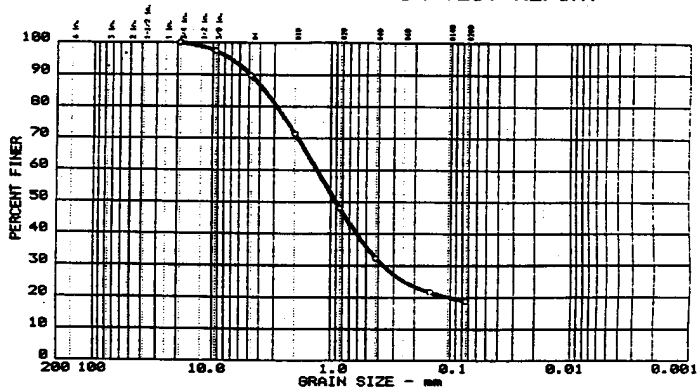
Date: 9-24-94

Remarks:
TEST PIT TP-SAL-2
SAMPLE NO. 2

PROCTOR TEST REPORT
SUELOS INC.

Figure No. 3

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	17	0.0	10.1	70.9	19.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			3.59	1.30	0.90	0.359				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	

Project No.:
Project: RIO NIGUA PROJECT, SALINAS, PUERTO RICO
○ Location: TEST PIT TP-SAL-3, SAMPLE No. 2

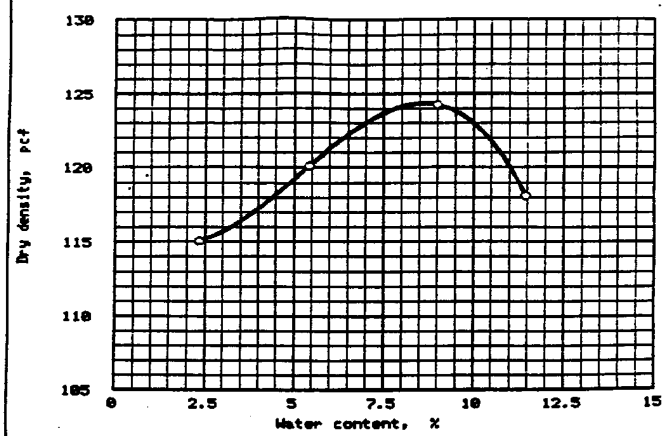
Date: 9-24-94

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Remarks:
TEST PIT TP-SAL-3
SAMPLE-2

Figure No. 1

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method C

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	SM		3 %				89.7 %	19.0 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 8.6 % Maximum dry density = 124.3 pcf	SILTY SAND

Project No.:
Project: RIO NIGUA, SALINAS, PUERTO RICO.
Location: TEST PIT TP-SAL-3, SAMPLE No. 2

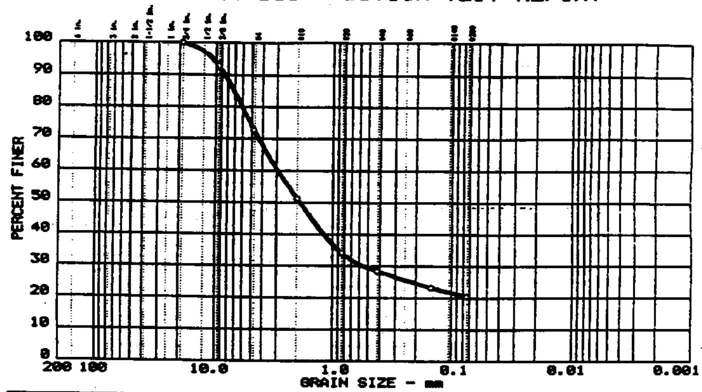
Date: 9-24-94

Remarks:
TEST PIT TP-SAL-3
SAMPLE NO. 2

PROCTOR TEST REPORT
SUELOS INC.

Figure No. 3

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
○	17	0.0	27.3	52.2	20.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			7.00	2.92	1.88	0.548				

MATERIAL DESCRIPTION	USCS	AASHTO
○ SILTY SAND	SM	

Project No.:
Project: RIO NIGUA PROJECT, SALINAS, PUERTO RICO
○ Location: TEST PIT TP-SAL-4, SAMPLE No. 2

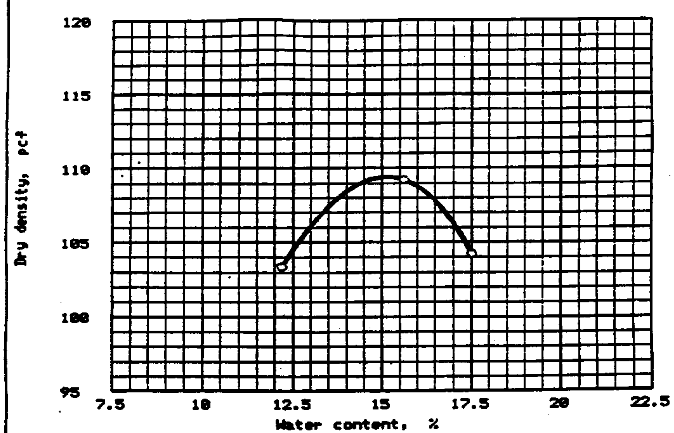
Date: 9-24-94

Remarks:
TEST PIT TP-SAL-4
SAMPLE NO. 2

GRAIN SIZE DISTRIBUTION TEST REPORT
SUELOS INC.

Figure No. 1

PROCTOR TEST REPORT



"Standard" Proctor, ASTM D 698, Method C

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	SM	A-2-4	10 %				72.7 %	20.5 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 15.1 % Maximum dry density = 109.4 pcf	SILTY SAND

Project No.:
Project RIO NIGUA, SALINAS, PUERTO RICO.
Location: TEST PIT TP-SAL-4, SAMPLE No. 2

Date: 9-24-94

Remarks:
TEST PIT TP-SAL-4
SAMPLE NO. 2

PROCTOR TEST REPORT
SUELOS INC.

Figure No. 3

RIO NIGUA AT SALINAS, PUERTO RICO

FEASIBILITY REPORT

APPENDIX C

DESIGN AND COST ESTIMATES

Table of Contents

Table of Contents (continued)

LIST OF TABLES

LIST OF PLATES

Appendix C
Design and Cost Estimates

A. INTRODUCTION

1. General. This Appendix presents a discussion of applicable design considerations and construction methods utilized to establish a basis for the cost estimates. General requirements for real estate and operation and maintenance are also presented.

B. DESIGN AND CONSTRUCTION

2. Channels. The existing river channel would be reestablished in some areas where the proposed levee construction would encroach on the channel cross section and impact conveyance. However, no new channel improvements would be implemented.

3. Levees. Three levee segments would be constructed along the Rio Nigua floodplain to provide SPF flood protection to the town of Salinas and the communities of Playa de Salinas and Coco. Conventional earth handling equipment would be used to construct the levees. Construction material would be obtained from the adjacent river channel and from the designated borrow area. A geotechnical discussion of the suitability of materials is provided in Appendix B. The levee would be constructed to satisfy the hydraulic requirements presented in Appendix A and would have a minimum crest width of 3.0 meters with side slopes of 1 vertical on 2.5 horizontal (1V:2.5H). Typical sections of the levee adjacent to the communities of Salinas and Coco are provided on Plates C-1 and C-2. Materials removed from the project area (including debris), which are unsuitable for levee construction, would be hauled to the designated off-site disposal area.

4. Drainage Culvert Structures. Culverts would be placed through the levee at three different locations within the project area in order to provide for interior drainage. The first culvert structure would be located north of the railroad tracks

at approximately Station 10+00, the second would be located north of the PR Highway 1 bridge at about Station 13+00, and the third would be located about 788 meters south of the PR Highway 52 bridge at Station 21+75. All culvert structures would consist of a required number of 5-foot diameter corrugated metal pipe (CMP) with flap gates. For all culvert structures, riprap and bedding stone would be placed along the upstream and downstream face of the levee embankment and for about 3 meters along the approach channel and 6 meters along the discharge channel. A culvert design table is provided in Appendix A.

5. Bank Protection. Grassing and gabion bank protection would be provided along areas of the levee alignments where erosive velocities are predicted. The primary use of erosion protection would be along the floodside levee side slope. Riprap would be utilized as standard practice in protecting the intake and discharge areas for the proposed culvert drainage structures.

6. Borrow and Disposal Areas.

a. Borrow Area. The approximately 50 acre area located on the Camp Santiago United States Military Reservation is proposed as the project borrow area. The site is located adjacent to PR Highway 154 approximately 5 kilometers north of the intersection of PR Highway 52. A detailed geotechnical discussion of the materials within the borrow area is provided in Appendix B. The location of the borrow area is shown on Plate B-4 in Appendix B.

b. Disposal Area. A designated disposal area, approximately 25 acres in size, is located west of the project just south of PR Highway 52. All debris and unsuitable material from construction of the project features would be placed in the disposal area. The location of the disposal area is shown on Plate B-4 in Appendix B.

C. RELOCATIONS

7. General. The project sponsor would be required to assume the costs for all relocations and alterations. These costs are based on the general alinements shown in the main report. Final

alinements would be determined upon completion of detailed topographic surveys and would be adjusted as necessary to minimize impacts on existing structures and utilities. The recommended plan presented in this report would require replacement of one existing bridge and some road relocation as discussed in the following paragraphs. All relocation of utilities, electric transmission lines, or telephone lines would be the responsibility of the project sponsor.

8. Highway Bridges. For the recommended plan, the bridge on PR Highway 1 would require replacement. The existing bridge has 2 lanes and is approximately 55 meters(180 ft.) long and 7.5 meters (24 ft.) wide. The replacement bridge would be about 75 meters (250 ft.) long and 12 meters(39 ft.) wide. A temporary detour would be required to maintain traffic flow across the Rio Nigua. A Bailey Bridge or similar structure would be constructed north of the existing bridge. The estimated cost of the replacement bridge, including the costs for bridge approaches, pavement, guardrail, construction and removal of temporary bridge, removal of existing bridge, and traffic control are provided in Table C-1 of this appendix.

9. Railroad Bridges. The railroad bridge which crosses the Rio Nigua downstream of PR Highway 1 is abandoned and would be removed as part of this project.

10. Road Relocations. Some road relocation would be required in conjunction with the bridge replacement on PR Highway 1, and two ramps would be required where the proposed levee crosses an existing roadway. One ramp would be required for the unpaved road south of the railroad, and another would be required where the levee crosses PR Highway 1 upstream of the PR Highway 52 bridge. Also, an unpaved access road would be provided along the west side of the river bank from PR Highway 1 to an existing road located past the Quebrada Honda. No other road relocations are anticipated.

11. Buildings. Improvement in conjunction with the PR Highway 1 bridge replacement would require acquisition of the Radio Station

and the Service Station (gas station) located on the southeast bank of bridge crossing.

12. Utilities. Water lines, electric power lines, and telephone lines would require relocation. The costs for relocation of these utilities are included in the cost estimate.

D. OPERATIONS AND MAINTENANCE

13. General. The project sponsor would be responsible for operation and maintenance of the improvements and features proposed in this report upon completion of the construction

project. The Contractor would be responsible for all maintenance during the construction contract.

14. Inspection. Joint field inspections with personnel from the U.S. Army Corps of Engineers and the local sponsor would be conducted on a regular basis to evaluate the performance and condition of the various project features. Additional field inspections would be conducted following a significant storm event. A discussion of the data collection and inspection requirements is presented in Appendix A, Paragraph V.E.6.

15. Estimated Annual Costs. The estimated annual operation and maintenance cost for the project is $45,500 for Salinas/Playa and $20,500 for Coco. These costs are based on removing accumulated debris and sediment from the channel and replacing or repairing the gabion bank protection on an annual basis or as required after a significant storm event. Levee maintenance also would consist of periodic mowing and erosion repair.

16. O&M Manual. Operation and maintenance of the project facilities would be performed in accordance with instructions prepared and incorporated in the "Operation and Maintenance Manual" which would be furnished to the project sponsor. The O&M Manual would be prepared in accordance with ER 1110-2-401.

E. COST ESTIMATES

17. General. The estimates of first cost for construction of the recommended plan were prepared using M-CACES software and are presented in Table C-1 for the Salinas/Playa segment and in Table C-2 for the Coco segment. Also, the cost of the non-construction features of the project is included. Each segment includes a narrative, a summary cost, and a detailed cost showing quantity, unit cost, and the amount for contingencies for each cost item.

The cost estimates are prepared for an effective date of August 1996.

TABLE C-1

RIO NIGUA - SALINAS/PLAYA
Without Floodway Improvements
Salinas and Playa Community
Salinas, Puerto Rico

Designed By: Jacksonville District
Estimated By: Jacksonville District - M.P.

Prepared By: Jacksonville District - M.P.

Preparation Date: 08/27/96
Effective Date of Pricing: 08/27/96
Est Construction Time: 540 Days

Sales Tax: 0.00%

M C A C E S G O L D E D I T I O N
Composer GOLD Software Copyright (c) 1985-1994
by Building Systems Design, Inc
Release 5.30A

LABOR ID: PRLB08 EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: FF0928

The recommended plan for the lower reach of the project consists of a levee from PR-52 Expressway to the ocean along the east banks of Rio Nigua.

In order to reduce real estate impacts, two levee sections were realigned into the existing river channel. Consequently, the river would be widen to existing conditions along the levee section, but this is not a floodway improvement. The floodside of this levee will be lined with 6" and 9" thick gabion mattresses to protect it from high velocity flows.

A Spur levee will be constructed from a ramp of PR-52 Expressway to PR-52 Expressway embankment. This levee will be protected with 9" thick gabion mattresses against high velocity flows. A road ramp on PR-1 Hwy to cross over the Spur Levee will be constructed. Also 12" thick gabions will be installed to protect the East abutment of PR-52 Bridge from erosion.

Interior drainage concrete culverts, provided with flapgates, will be located at three different locations under the proposed levee.

PR-1 Hwy bridge will be replaced and an abandoned railroad bridge will be removed. Also an unpaved access road will be constructed.

Fill material for levees will be used from project excavations as a primary source. According to geotechnical investigations 95% of the excavated material from the river channel will be suitable to use for the levees. A second source to obtain fill material will be required because the channel excavations will not suffice the levee fill requirements. A borrow area located in Camp Santiago at approx 7.5 KMs (4.7 mi) will be used. According to geotechnical investigations, 85% of the excavated material from the borrow area will be suitable to construct the levees.

A Disposal Area was identified within 2 KM (1.25 miles) of the project.

To make room for the PR-1 Hwy Bridge replacement, a radio station at this vicinity would require adquisition. A gas station, currently under operations, which is also at this vicinity, is being considered for relocation, but we are not certain at this moment. A field inspection was performed and it was concluded the USTs are not likely to be a soil contamination problem. However, if it turns out that relocation of the gas station is necessary, enough money was included in the cost estimate to cover for relocation of the structure (including USTs) and removal of contaminated soil if any.

Also water supply lines (2" and 4"), a 30" Dia. Siphon, power lines and telephone lines will be required to be relocated.

Contingencies were included in the amount of 20% of the construction cost to cover unknowns, uncertainties and/or unanticipated conditions.

Wed 04 Sep 1996 U.S. Army Corps of Engineers TIME 13:49:07
Eff. Date 08/27/96 PROJECT NIGUID: RIO NIGUA - SALINAS/PLAYA - Without Floodway Improvements
RECOMMENDED PLAN SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Feature (Rounded to 100's) **

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A CONSTRUCTION FEATURES					
A_02 RELOCATIONS		2,186,900	437,400	2,624,300	
A_09 CHANNELS AND CANALS		527,500	105,500	633,000	
A_11 LEVEES AND FLOODWALLS		2,432,900	486,600	2,919,400	
TOTAL CONSTRUCTION FEATURES		5,147,300	1,029,500	6,176,700	
B NON-CONSTRUCTION FEATURES					
B_01 LANDS AND DAMAGES		1,915,700	478,800	2,394,500	
B_18 CULTURAL RESOURCE PRESERVATION		54,500	5,500	60,000	
B_30 PLANNING, ENGINEERING AND DESIGN		477,000	119,300	596,300	
B_31 CONSTRUCTION MANAGEMENT		524,000	131,000	655,000	
TOTAL NON-CONSTRUCTION FEATURES		2,971,200	734,600	3,705,800	
TOTAL RIO NIGUA - SALINAS/PLAYA		8,118,500	1,764,000	9,882,500	

LABOR ID: PRL8D8 EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PRO92B

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A CONSTRUCTION FEATURES					
A_02 RELOCATIONS					
A_02.01 Roads, Construction Activities					
A_02.01.01 Mobiliz, Demobiliz and Prep Work					
A_02.01.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	73,800	14,800	88,500	88516
TOTAL Mobiliz, Demobiliz and Prep Work		73,800	14,800	88,500	
A_02.01.02 Site Work					
A_02.01.02. 1 Temp. Detour Roads f/PR-1 Bdge.	2000.00 LF	63,000	12,600	75,600	37.80
A_02.01.02. 2 12" Th.Gabions- PR-52 Bdge Abut.	1500.00 CY	156,600	31,300	187,900	125.24
A_02.01.02. 3 Revetment Protection f/PR-1 Bdge	1.00 JOB	38,800	7,800	46,600	46587
A_02.01.02. 4 Construct Unpaved Access Road	5053.00 LF	39,200	7,800	47,100	9.32
TOTAL Site Work		297,600	59,500	357,100	
A_02.01.05 Bridges, Removal					
A_02.01.05. 1 Remove Existing PR-1 Hwy Bridge	6455.00 SF	79,200	15,800	95,000	14.72
A_02.01.05. 2 Remove Exist. Ford & Dirt Road	1.00 JOB	15,300	3,100	18,400	18394
TOTAL Bridges, Removal		94,500	18,900	113,400	
A_02.01.07 Bridges, New Construction					
A_02.01.07. 1 Concrete Bridge at PR-1 Hwy	9700.00 SF	594,700	118,900	713,700	73.58
A_02.01.07. 2 Temporary Bridge for PR-1 Hwy.	4000.00 SF	129,400	25,900	155,300	38.82
TOTAL Bridges, New Construction		724,200	144,800	869,000	
A_02.01.19 Construct Roadbed to Subgrade					
A_02.01.19. 1 Remove Exist Pvmt, PR-½ Rd	3000.00 SY	8,400	1,700	10,100	3.35
A_02.01.19. 2 Borrow Material PR-1 Bdge Ramps	23000.00 CY	148,800	29,800	178,600	7.76
A_02.01.19. 3 Remove Exist Pvmt, PR-504 Rd	500.00 SY	1,400	300	1,700	3.35
A_02.01.19. 4 Ramp Fill for PR-1 Highway	20000.00 CY	92,100	18,400	110,600	5.53
A_02.01.19. 5 Road Ramp for the 60 Acre Parcel	3000.00 CY	13,800	2,800	16,600	5.53
TOTAL Construct Roadbed to Subgrade		264,600	52,900	317,500	

Wed 04 Sep 1996 U.S. Army Corps of Engineers TIME 13:49:07
Eff. Date 08/27/96 PROJECT NIGUID: RIO NIGUA - SALINAS/PLAYA - Without Floodway Improvements
RECOMMENDED PLAN SUMMARY PAGE 3
** PROJECT OWNER SUMMARY - Item (Rounded to 100's) **

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A_02.01.39 Road Surfacing					
A_02.01.39. 1 Bit.Pavement for PR-1 Rd (Bdge)	4960.00 TON	205,400	41,100	246,500	49.69
A_02.01.39. 2 Base Course Mat.for PR-1 Rd(Bdg)	3080.00 CY	59,800	12,000	71,700	23.29
A_02.01.39. 3 New Pvmt & Base f/PR-1 Hwy Ramp	8000.00 SY	165,600	33,100	198,800	24.85
TOTAL Road Surfacing		430,800	86,200	517,000	
A_02.01.99 Associated General Items					
A_02.01.99. 1 Guardrail	2624.00 LF	54,300	10,900	65,200	24.85
A_02.01.99. 2 Utility Relocation	1.00 JOB	19,900	4,000	23,900	23915
TOTAL Associated General Items		74,300	14,900	89,100	
TOTAL Roads, Construction Activities		1,959,700	391,900	2,351,600	
A_02.02 Railroads, Constr. Activities					
A_02.02.01 Mobiliz, Demobiliz and Prep Work					
A_02.02.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	2,800	600	3,400	3416.40
TOTAL Mobiliz, Demobiliz and Prep Work		2,800	600	3,400	
A_02.02.05 Bridges, Foundations					
A_02.02.05. 1 Railroad Bridge Removal	1.00 JOB	14,900	3,000	17,900	17858
TOTAL Bridges, Foundations		14,900	3,000	17,900	
TOTAL Railroads, Constr. Activities		17,700	3,500	21,300	
A_02.03 Cemeteries, Utilities and Struct					
A_02.03.01 Mobiliz, Demobiliz and Prep Work					
A_02.03.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	11,600	2,300	14,000	13976
TOTAL Mobiliz, Demobiliz and Prep Work		11,600	2,300	14,000	
A_02.03.02 Utilities					
A_02.03.02. 1 2" and 4" Water Lines, by PRASA	1.00 JOB	10,700	2,100	12,900	12859
A_02.03.02. 2 30" Dia Siphon, irrig, by PREPA	1.00 JOB	32,100	6,400	38,600	38578
A_02.03.02. 3 Electric Power Lines, by PREPA	1.00 JOB	53,600	10,700	64,300	64297

LABOR ID: PRL8D6 EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PR092B

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A_02.03.02. 4 Telephone Lines, by PRTC	1.00 JOB	16,100	3,200	19,300	19289
TOTAL Utilities		112,500	22,500	135,000	
A_02.03.03 Structures					
A_02.03.03. 1 Radio Station, excluding antenna	1.00 JOB	20,100	4,000	24,100	24070
A_02.03.03. 2 Gas Station, including UST	1.00 JOB	65,200	13,000	78,300	78267
TOTAL Structures		85,300	17,100	102,300	
TOTAL Cemeteries, Utilities and Struct		209,400	41,900	251,300	
TOTAL RELOCATIONS		2,186,900	437,400	2,624,300	
A_09 CHANNELS AND CANALS					
A_09.01 Channels					
A_09.01.01 Mobiliz, Demobiliz and Prep Work					
A_09.01.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	20,700	4,100	24,800	24847
TOTAL Mobiliz, Demobiliz and Prep Work		20,700	4,100	24,800	
A_09.01.31 Earthwork					
A_09.01.31. 1 Clearing and Grubbing	58.00 ACR	52,500	10,500	63,000	1087.04
A_09.01.31. 2 Channel Excav/Disp (Realinement)	125200.00 BCY	454,300	90,900	545,200	4.35
TOTAL Earthwork		506,800	101,400	608,200	
TOTAL Channels		527,500	105,500	633,000	
TOTAL CHANNELS AND CANALS		527,500	105,500	633,000	
A_11 LEVEES AND FLOODWALLS					
A_11.01 Levees					
A_11.01.01 Mobiliz, Demobiliz and Prep Work					
A_11.01.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	78,900	15,800	94,700	94728
TOTAL Mobiliz, Demobiliz and Prep Work		78,900	15,800	94,700	

Wed 04 Sep 1996 U.S. Army Corps of Engineers TIME 13:49:07
Eff. Date 08/27/96 PROJECT NIGUSO: RIO NIGUA - SALINAS/PLAYA - Without Floodway Improvements
RECOMMENDED PLAN SUMMARY PAGE 5
** PROJECT OWNER SUMMARY - Item (Rounded to 100's) **

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A_11.01.02 Drainage					
A_11.01.02. 1 Culvert 1, 1-60" Dia CMP, w/FG	1.00 JOB	21,900	4,400	26,300	26278
A_11.01.02. 2 Culvert 2, 2-60" Dia CMP, w/FG	1.00 JOB	44,400	8,900	53,300	53332
A_11.01.02. 3 Culvert 3, 1-60" Dia CMP, w/FG	1.00 JOB	28,500	5,700	34,200	34226
TOTAL Drainage		94,900	19,000	113,900	
A_11.01.31 Earthwork					
A_11.01.31. 1 Clearing and Grubbing	22.00 ACR	28,500	5,700	34,200	1552.91
A_11.01.31. 2 Main Levee Fill, f/Channel Exc	118900.00 CCY	180,000	36,000	216,000	1.82
A_11.01.31. 3 Main Levee Fill, from B/A	132200.00 CCY	647,900	129,600	777,500	5.88
A_11.01.31. 4 Spur Levee Fill, from B/A	19200.00 CCY	95,100	19,000	114,100	5.94
TOTAL Earthwork		951,400	190,300	1,141,700	
A_11.01.86 Gabion Slope Protection					
A_11.01.86. 1 6" Th.Gabion Mattr.-Sta.1 to 26	5300.00 CY	832,600	166,500	999,100	188.51
A_11.01.86. 2 9" Th.Gabion Mattr. Sta.26 to 30	2070.00 CY	245,800	49,200	294,900	142.48
A_11.01.86. 3 9" Th.Gabion Mattr. Spur Levee	1930.00 CY	229,300	45,900	275,200	142.57
TOTAL Gabion Slope Protection		1,307,700	261,500	1,569,200	
TOTAL Levees		2,432,900	486,600	2,919,400	
TOTAL LEVEES AND FLOODWALLS		2,432,900	486,600	2,919,400	
TOTAL CONSTRUCTION FEATURES		5,147,300	1,029,500	6,176,700	
B NON-CONSTRUCTION FEATURES					
B_01 LANDS AND DAMAGES					
B_01.AA Project Planning		16,000	4,000	20,000	
TOTAL Project Planning		16,000	4,000	20,000	
B_01.B- Acquisitions					
B_01.B-.20 By Local Sponsor (LS)		243,000	60,700	303,700	
B_01.B-.40 Review of LS		98,000	24,500	122,500	
TOTAL Acquisitions		341,000	85,200	426,200	

LABOR ID: PRL80B EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PRO92B

Wed 04 Sep 1996 U.S. Army Corps of Engineers TIME 13:49:07
Eff. Date 08/27/96 PROJECT NIGUSD: RIO NIGUA - SALINAS/PLAYA - Without Floodway Improvements
RECOMMENDED PLAN SUMMARY PAGE 6
** PROJECT OWNER SUMMARY - Item (Rounded to 100's) **

	QUANTITY	UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
B_01.C- Condemnations						
B_01.C-.20 By Local Sponsor (LS)			60,000	15,000	75,000	
B_01.C-.40 Review of LS			15,000	3,700	18,700	
TOTAL Condemnations			75,000	18,700	93,700	
B_01.E- Appraisals						
B_01.E-.30 By Local Sponsor (LS)			145,000	36,200	181,200	
B_01.E-.50 Review of LS			72,500	18,100	90,600	
TOTAL Appraisals			217,500	54,400	271,900	
B_01.F- PL 91-646 Assistance						
B_01.F-.20 By Local Sponsor (LS)			37,000	9,200	46,200	
B_01.F-.40 Review of LS			18,500	4,600	23,100	
TOTAL PL 91-646 Assistance			55,500	13,900	69,400	
B_01.G- Temp Permits/Licenses/ ROE						
B_01.G-.20 By Local Sponsor (LS)			2,300	600	2,900	
B_01.G-.40 Review of LS			1,200	300	1,500	
B_01.G-.60 Damage Claims			1,300	300	1,600	
TOTAL Temp Permits/Licenses/ ROE			4,800	1,200	6,000	
B_01.M- Project Admi.-R.E. Review of PCA			2,000	500	2,500	
B_01.R- Real Estate Payments						
B_01.R-.10 Land Payments- By Local Sponsor			863,900	215,900	1,079,800	
B_01.R-.20 PL 91-646 Assist.Payments-By LS			340,000	85,000	425,000	
TOTAL Real Estate Payments			1,203,900	300,900	1,504,800	
TOTAL LANDS AND DAMAGES			1,915,700	478,800	2,394,500	
B_18 CULTURAL RESOURCE PRESERVATION			54,500	5,500	60,000	
B_30 PLANNING, ENGINEERING AND DESIGN			477,000	119,300	596,300	
B_31 CONSTRUCTION MANAGEMENT			524,000	131,000	655,000	
TOTAL NON-CONSTRUCTION FEATURES			2,971,200	734,600	3,705,800	
TOTAL RIO NIGUA - SALINAS/PLAYA			8,118,500	1,764,000	9,882,500	

LABOR ID: PRL80B EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PRO92B

TABLE C-2

RIO NIGUA - COCO COMMUNITTY
Salinas, Puerto Rico

Designed By: Jacksonville District
Estimated By: Jax District - M.P.

Prepared By: Jax District - M.P.

Preparation Date: 08/27/96
Effective Date of Pricing: 08/27/96
Est Construction Time: 240 Days

Sales Tax: 0.00%

M C A C E S G O L D E D I T I O N
Composer GOLD Software Copyright (c) 1985-1994
by Building Systems Design, Inc.
Release 5.30A

LABOR ID: PRL80B EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PRO92P

The recommended plan for this segment of Rio Nigua at Salinas consists of a levee that would provide protection to the community of Coco.

The levee would begin on the west side of PR-1 at a ground elevation of 50 meters NGVD just north of the community of Coco. The levee will run southward paralleling PR-1, extending for a total length of 3,930 LM (2.44 miles).

The levee will be protected with grassing all the way along its length.

Fill material for levees will be used from a Borrow Area, located at Camp Santiago at 7.5 Kms (4.7 miles), since the excavated material from project excavations will be used for the lower reach (Town and Playa of Salinas). An 85% of Borrow Area excavations is suitable to use for the levee embankment according to geotechnical investigations.

Contingencies are included in the amount of 20% of the construction cost to cover unknowns, uncertainties and/or unanticipated conditions.

Wed 04 Sep 1996 U.S. Army Corps of Engineers TIME 13:44:45
Eff. Date 08/27/96 PROJECT NIGCOC: RIO NIGUA - COCO COMMUNITTY - Salinas, Puerto Rico
RECOMMENDED PLAN SUMMARY PAGE 1
** PROJECT OWNER SUMMARY - Feature (Rounded to 100's) **

	QUANTITY	UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A CONSTRUCTION FEATURES						
A_11 Levees and Floodwalls			1,795,500	359,100	2,154,600	
TOTAL CONSTRUCTION FEATURES			1,795,500	359,100	2,154,600	
B NON-CONSTRUCTION FEATURES						
B_01 LANDS AND DAMAGES			178,500	44,400	222,900	
B_30 PLANNING, ENGINEERING AND DESIGN			180,000	36,000	216,000	
B_31 CONSTRUCTION MANAGEMENT			198,000	39,600	237,600	
TOTAL NON-CONSTRUCTION FEATURES			556,500	120,000	676,500	
TOTAL RIO NIGUA - COCO COMMUNITTY			2,352,000	479,100	2,831,100	

LABOR ID: PRLBD8 EQUIP ID: RG1192 Currency in DOLLARS CREW ID: PRCR92 UPB ID: PRO92B

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
A CONSTRUCTION FEATURES					
A_11 Levees and Floodwalls					
A_11.01 Levees					
A_11.01.01 Mobiliz, Demobiliz and Prep Work					
A_11.01.01. 1 Mobiliz, Demobiliz and Prep Work	1.00 JOB	51,800	10,400	62,100	62116
TOTAL Mobiliz, Demobiliz and Prep Work		51,800	10,400	62,100	
A_11.01.31 Earthwork					
A_11.01.31. 1 Clearing and Grubbing	37.00 ACR	33,000	6,600	39,600	1071.51
A_11.01.31. 3 Levee Fill, from Borrow Area	350000.00 CCY	1,655,800	331,200	1,987,000	5.68
TOTAL Earthwork		1,688,900	337,800	2,026,700	
A_11.01.99 Associated General Items					
A_11.01.99. 1 Slope Protection by Grassing	35.00 ACR	54,900	11,000	65,900	1881.71
TOTAL Associated General Items		54,900	11,000	65,900	
TOTAL Levees		1,795,500	359,100	2,154,600	
TOTAL Levees and Floodwalls		1,795,500	359,100	2,154,600	
TOTAL CONSTRUCTION FEATURES		1,795,500	359,100	2,154,600	
B NON-CONSTRUCTION FEATURES					
B_01 LANDS AND DAMAGES					
B_01.AA Project Planning		4,000	1,000	5,000	
TOTAL Project Planning		4,000	1,000	5,000	
B_01.B- Acquisitions					
B_01.B-.20 By Local Sponsor (LS)		12,000	3,000	15,000	
B_01.B-.40 Review of LS		4,000	1,000	5,000	
TOTAL Acquisitions		16,000	4,000	20,000	

	QUANTITY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT
B_01.C- Condemnations					
B_01.C-.20 By Local Sponsor (LS)		0	0	0	
B_01.C-.40 Review of LS		0	0	0	
TOTAL Condemnations		0	0	0	
B_01.E- Appraisals					
B_01.E-.30 By Local Sponsor (LS)		5,000	1,200	6,200	
B_01.E-.50 Review of LS		2,500	600	3,100	
TOTAL Appraisals		7,500	1,900	9,400	
B_01.F- PL 91-646 Assistance					
B_01.F-.20 By Local Sponsor (LS)		0	0	0	
B_01.F-.40 Review of LS		0	0	0	
TOTAL PL 91-646 Assistance		0	0	0	
B_01.G- Temporary Permits/ Licenses/ ROE					
B_01.G-.20 By Local Sponsor (LS)		1,700	400	2,100	
B_01.G-.40 Review of LS		800	200	1,000	
B_01.G-.60 Damage Claims		1,700	400	2,100	
TOTAL Temporary Permits/ Licenses/ ROE		4,200	1,000	5,200	
B_01.M- Project Admin.- RE Review of PCA		0	0	0	
B_01.R- Real Estate Payments					
B_01.R-.1B Land Payments - By LS		146,800	36,500	183,300	
B_01.R-.2B PL 91-646 Assistance Pymts-By LS		0	0	0	
TOTAL Real Estate Payments		146,800	36,500	183,300	
TOTAL LANDS AND DAMAGES		178,500	44,400	222,900	
B_30 PLANNING, ENGINEERING AND DESIGN		180,000	36,000	216,000	
B_31 CONSTRUCTION MANAGEMENT		198,000	39,600	237,600	
TOTAL NON-CONSTRUCTION FEATURES		556,500	120,000	676,500	
TOTAL RIO NIGUA - COCO COMMUNITTY		2,352,000	479,100	2,831,100	

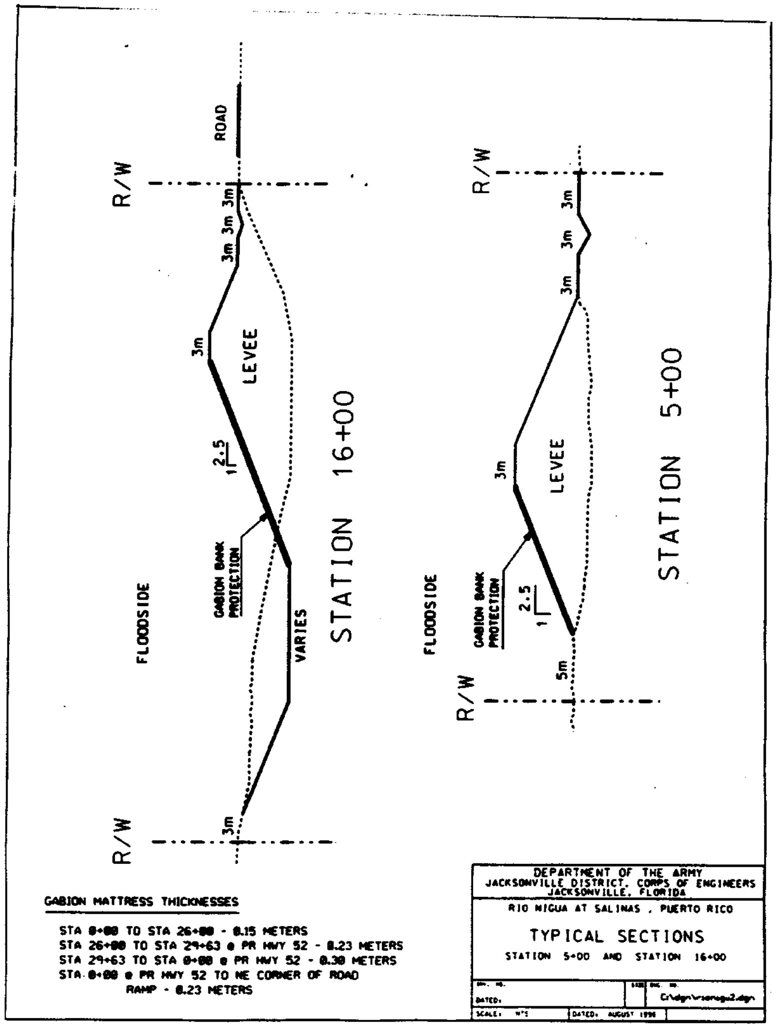

R/W
ROAD
3m
3m 3m
LEVEE
2.5
1
GABION BANK PROTECTION
FLOODSIDE
VARIES
STATION 16+00
5m
STATION 5+00
GABION MATTRESS THICKNESSES
STA 0+00 TO STA 26+00 - 0.15 METERS
STA 26+00 TO STA 29+63 @ PR HWY 52 - 0.23 METERS
STA 29+63 TO STA 0+00 @ PR HWY 52 - 0.30 METERS
STA 0+00 @ PR HWY 52 TO NE CORNER OF ROAD RAMP - 0.23 METERS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
RIO NIGUA AT SALINAS, PUERTO RICO
TYPICAL SECTIONS
STATION 5+00 AND STATION 16+00
DATED:
SCALE: NTS
DATED: AUGUST 1996

PLATE C-1

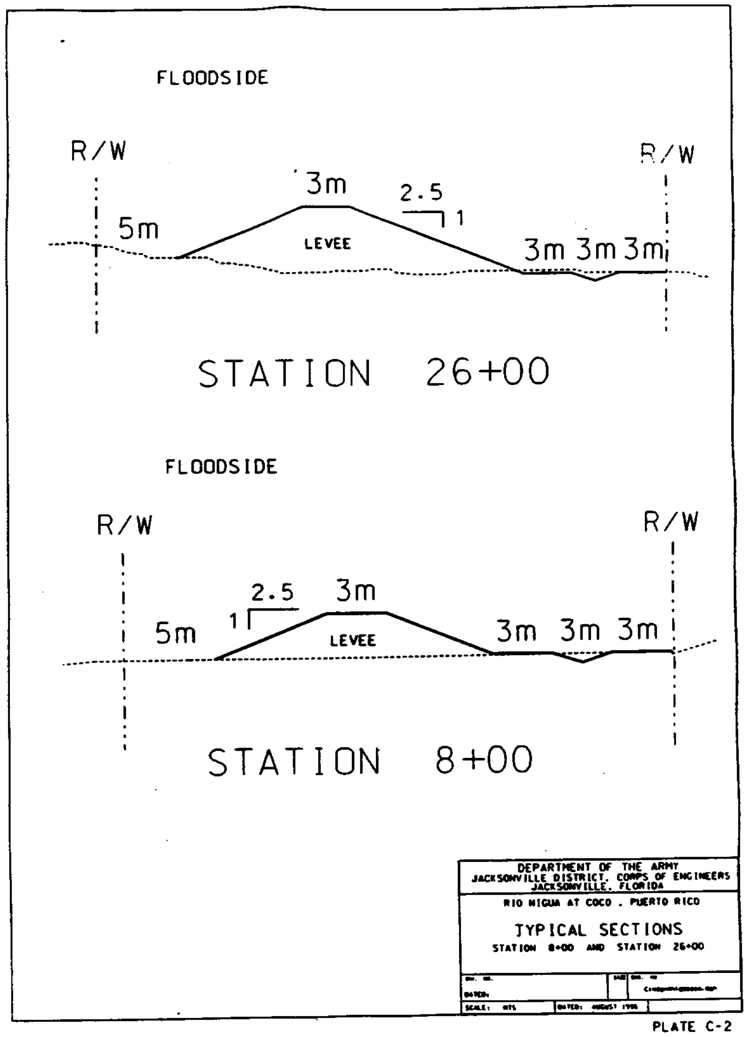

FLOODSIDE
R/W
R/W
3m
2.5
1
5m
LEVEE
3m 3m 3m
STATION 26+00
FLOODSIDE
R/W
R/W
2.5
3m
1
5m
LEVEE
3m 3m 3m
STATION 8+00
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
RIO NIGUA AT COCO . PUERTO RICO
TYPICAL SECTIONS
STATION 8+00 AND STATION 26+00
SCALE:
DATED:

PLATE C-2

RIO NIGUA AT SALINAS FEASIBILITY REPORT

APPENDIX D
COORDINATION

A. Introduction

The purpose of this appendix is to document the internal coordination process and the public involvement that underlines this feasibility report. Focus is on the coordination within the District and South Atlantic Division (SAD), and the meetings for the public participation.

B. Study process

The study was requested by the Puerto Rico Resident Commissioner in Washington in letter dated June 19, 1985, and it was authorized in October 1986. The Reconnaissance Report was initiated in March 1989 and completed in March 1990. Enclosed is copy of the reconnaissance report evaluation process. The feasibility study was developed based on this evaluation process.

A Study Management Team (SMT) was organized with participation from several technical disciplines within the U.S. Army Corps of Engineer (USACE) Jacksonville District (i.e. Planning Division, Engineering Division, Environmental Branch, and Real Estate Division). Throughout the study process, a significant amount of SMT meetings were held to discuss and resolve issues within the study process. Enclosed is the record of one of these meetings.

Three Technical Review Conferences were held between the District and SAD to coordinate study plan formulation and evaluation efforts to assure completion of a quality feasibility/decision report. Conferences were held on March 24, 1993, October 18, 1994, and June 1, 1995. Enclosed is information on these meetings.

C. Community Meetings

Funds to initiate feasibility study were received in March 1992. A community meeting was held on August 11, 1992, in the Municipality of Salinas Assembly Room to inform about the results of the reconnaissance report and to initiate study public coordination. The meeting was chaired by representatives from the USACE and the local sponsor (Department of Natural and Environmental Resources).

The study process was concluded with a second community meeting held on May 23, 1996, to present study results. Like the first one, the meeting was co-chaired between the USACE and the DNER.

Enclosed is summarized information on the results from these meetings.

RECONNAISSANCE REPORT
ISSUE RESOLUTION CONFERENCE

CESAJ-PG

August 24, 1990

MEMORANDUM FOR THE RECORD

SUBJECT: Río Nigua at Salinas, P. R., Reconnaissance Report Issue Resolution Conference

1. On 15 August 1990 the Issue Resolution Conference for the Río Nigua at Salinas Reconnaissance Report took place in the Jacksonville District. The conference was to discuss the report and potential issues that need to be thoroughly addressed during the feasibility study. Enclosure 1 provides a list of attendees at the conference.

2. For economic reasons the IRC was held in Jacksonville. It was correctly assumed that Puerto Rican environmental agencies would not be able to budget for travel to the states. To comply with recent guidance on interagency coordination a local pre-IRC meeting was arranged in Puerto Rico. Therefore, on 19 July 1990, Federal and Commonwealth agencies met in the San Juan Area Office to discuss environmental issues and concerns associated with the flood control project for Río Nigua. Enclosure 2 includes the invitation, mailing list, attendance list, and summary of significant comments. Although the USF&WLS was unable to attend they sent their review comments (see enclosure 3). Both the interagency meeting, summary and USF&WL letter were presented at the IRC.

3. It was the general concensus that subject report provides adequate justification for proceeding to the feasibility phase. However, both the scope of work and study cost will have to be revised to reflect IRC comments for the next phase. All comments provided by SAD and OCE prior to the conference will become part of the study record and will be incorporated, when applicable, into the feasibility study scope of work.

4. The conference was opened with brief introductory remarks by SAD, OCE, and District staff. Then Messrs. Roberto Cortés and Edil Rosas gave a summary of the reconnaissance study and the recommendations.

5. The following comments regarding plan formulation were made:

a. The use of a floodgate, where warning times are short, should not be considered as part of the flood control project. To this comment the following was added: The alternative of ramping PR Highway 1 to replace the floodgate at this location will be considered in the feasibility phase. However, the floodgate at the railroad can be kept closed during the critical period of intensive rainfall (i.e. June - November). The railroad is used by slow moving, single man-driven engines transporting sugar cane during the months of December through March. An automated system should be adequate for this purpose. The short warning system and the possibility of using a floodgate at the railroad will be evaluated in detail.

b. The impact on flood stages in the unprotected portion of the flood plain should be evaluated to assure it will not exceed P. R. Planning Board criteria.

c. A debris basin should be considered for the flood control alternatives involving channelization.

d. A sediment assessment should be performed as part of the feasibility study to determine the need for sediment traps as part of flood control alternatives.

e. Since PR Highway 52 will be part of the proposed Corps project, its structural condition and construction characteristics should be evaluated to determine conformity with Corps standards.

f. A flood warning system should be addressed in the feasibility phase as part of the flood protection project.

g. A diversion channel starting north from PR Highway 52 and a flood control dam should be considered in the feasibility phase.

6. The socioeconomic analysis for the next phase should consider the following:

a. Look at potential agricultural benefits from reduced damages to cultivated farm lands that would be protected by proposed plans.

b. If high overbank velocity conditions exist, associated structural damages should be calculated. SAD may be able to provide programs that can evaluate such damages.

c. Improvements for Salinas and Coco must be developed both as a system and separately. Each segment must be justified incrementally.

d. The estimated recurrence interval for historic floods and a breakdown of damages (bridges, highway, etc.) should be provided if available.

e. Since any new development in flood prone areas should be constructed at or over the 100-year flood elevation (P. R. Planning Board regulation number 13), no benefits for reduction in damages to new developments will be considered for floods of 100-year events or less.

f. Business losses should not generally be considered as NED benefits.

7. The feasibility study scope of work will be revised to reflect the following comments:

a. A GDM and associated reformulation and Washington Level Review will not be required. However, a Feature Design Memorandum (FDM) is required. The PMP will be reviewed to reflect these changes.

b. The scope of H&H work and costs will be revised to include a sediment assessment.

c. Surveys will be required above PR Highway 52. The survey scope and cost estimate will be reviewed to reflect this.

d. The Real Estate scope and cost estimate will be revised to include providing preliminary and final Real Estate values, as well as preparation of the Gross Appraisal.

e. The cost of subsurface investigation will be reviewed. G&M work may need to include work on PR Highway 52, to help determine if its construction meets Corps criteria and it can be included as part of the project.

8. Although the sponsor, the Puerto Rico Department of Natural Resources was unable to attend the IRC they have expressed their strong support for continued study into the feasibility phase. However, because of severe damages resulting from Hurricane Hugo's passage near Fajardo, DNR has elected to fund a 205 study there as their first priority. They have requested that initiation of the Rio Nigua study be rescheduled for Fiscal Year 92. This will allow the district adequate time to revise the Scope of Work, Study cost, and negotiate a FCSA.

ROBERTO CORTES COLON
Chief, Planning Section

Encls.
1. List of Attendees
2. MFR

RIO NIGUA AT SALINAS
RECON RESOLUTION CONFERENCE

NAME	ORGANIZATION	PHONE
John W. Rushing	CESAD-PD	404/331-1786
Eddie Salem	CESAJ-PD	904/791-2238
Let Mon Lee	CECW-PE	202/272-1721
Richard Bonner	CESAJ-DP	904/791-2586
George Strain	CESAD-PD-P	404/331-4328
Angie Premo	CESAD-PP-C	404/331-3882
Jim Orsak	CESAD-EN-HH	404/331-6706
Mike Choate	CESAJ-EN-HI	904/791-3143
Jerry W. Webb	CECW-EH	202/272-8514
Eric Raasch	CESAJ-PD-D	904/791-3680
Russ Weeks	CESAJ-EN-DL	904/791-3873
Bill Fonferek	CESAJ-PD-ES	904/791-1690
Henry Anderson	CESAJ-EN-HH	904/791-2106
Miguel Rodriguez	CESAJ-PG	809/729-6893
Eric Holand	CESAJ-EN-HH	904/791-2108
Rona Mazer	CESAJ-PD-ER	904/791-1686
Isabel Suazo	CESAJ-PG	809/729-6893
Bob Newman	CESAJ-PD-PB	904/791-1695
Randy Bush	CESAJ-EN-GS	904/791-1618
Cleve Powell	CESAJ-RE	904/791-1178
Diane Grace	CESAJ-RE-A	904/791-3877
Aaron Kelly	CESAJ-EN-DS	904/791-2260
Gerald Atmar	CESAJ-PD-ES	904/791-2615
Roberto Cortes	CESAJ-PG	809/729-6893
Edil Rosas	CESAJ-PG	809/729-6893
Ken Claseman	CESAD-PD-E	404/331-6820
William Hunt	CECW-PD	202/272-8569

CESAJ-PG

August 8, 1990

MEMORANDUM FOR THE RECORD

SUBJECT: Interagency Meeting Río Nigua at Salinas Reconnaissance Report

1. An interagency meeting to discuss environmental issues and concerns associated with the Río Nigua at Salinas flood control project was held on 19 July 1990 at the Corps office in San Juan. Enclosure 1 provides copy of letter and addressees,and list of attendees.

2. The purpose of the meeting was to provide a forum to the local and Federal agencies in Puerto Rico to discuss environmental issues and concerns related to proposed flood control project for Río Nigua at Salinas. The meeting was chaired by Eng. Hilton Miró Detrés, Assistant Secretary for Flood Control Area, Department of Natural Resources, and the subscriber.

3. Representatives from the P. R. Department of Agriculture, the P. R. Land Authority, and the P. R. Planning Board were present. No other agency was present nor provided an input to the meeting.

4. The following is a summary of the information and concerns presented at the meeting:

a. The subscriber gave a brief presentation of the alternatives to be considered for the feasibility phase.

b. Mr. Saldaña, P. R. Land Authority, expressed the endorsement of the agency to the flood control project and provided the following information:

(1) The agency has no lands within the project area.

(2) That the agriculture activity in the area is basically concentrated in vegetables. Therefore, a flood control project will benefit this important element of the local economy.

c. Mr. Granell, P. R. Department of Agriculture, expressed his concerns about the impact on the ground water availability.

d. The subscriber explained that the impact on ground water recharge would be addressed as part of the feasibility study. However, since extraordinary floods occur probably every 5 to 10 years, ground water yield in the area should not be closely related to recharge by the Río Nigua overland flow. The riverbed will not be made impermeable. Therefore, the ground water recharge through the riverbed should not be impacted.

Encl.

ROBERTO CORTES COLON
Chief, Planning Section

RIO NIGUA AT SALINAS COORDINATION MEETING
JULY 19,1990

LIST OF ATTENDEES

NAME	AGENCY	PHONE
Edwin G. Grawell	Dept of Agriculture	809/725-3040
Herminio A. Saldana	Aud do Tierras de P.R.	809/723-9090
Ruben	Junta de Plan	809/723-6200
Hilton Miro	DRN	809/725-3852
Roberto Cortes	CESAJ-PC	809/729-6893

DEPARTMENT OF THE ARMY
SAN JUAN AREA OFFICE, JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
400 FERNANDEZ JUNCOS AVENUE
SAN JUAN, PUERTO RICO 00901-3299

REPLY TO
ATTENTION OF

June 25, 1990

Planning Section

"F1"

Dear "F2":

The U. S. Army Corps of Engineers has completed the reconnaissance phase of the flood control study for Rio Nigua at Salinas, Puerto Rico. The study was authorized by a Resolution of the Committee of Public Works and Transportation of the U. S. House of Representatives dated October 1, 1986. The study was requested by the Puerto Rico Resident Commissioner in Washington in a letter dated June 19, 1985. The Department of Natural Resources is the local sponsor. Enclosed for your information and comments is a copy of the report.

It is a Corps policy that environmental resources conservation be given equal consideration with other study purposes in the formulation and evaluation of alternative plans. This office, in an effort to adequately identify environmental resources that could be impacted by a flood control measure, is coordinating an interagency meeting to discuss issues that may affect the flood control study for Rio Nigua. The meeting is scheduled to take place at the Corps of Engineers Office in San Juan on July 19, 1990, at 9:00 a. m.

It would be a pleasure to have you or your representative participate in this meeting.

Sincerely,

William T. Coffey
Lt Col, Corps of Engineers
Deputy District Engineer for
Puerto Rico & Virgin Islands

Enclosure

MAILING LIST
Rio Nigua de Salinas Letter
Dated June 25, 1990

Subject: Interagency Meeting of July 19, 1990

Honorable José E. Laborde
Secretary of Natural Resources
P. O. Box 5887, Puerta de Tierra
San Juan, Puerto Rico 00906

Eng. Patria Custodio
Chairwoman, PR Planning Board
P. O. Box 41119, Minillas Station
San Juan, Puerto Rico 00940

Ms. Inés Monefeldd
Director, Coastal Zone Management
Department of Natural Resources
P. O. Box 5887, Puerta de Tierra
San Juan, Puerto Rico 00906

Mr. Santos Rohena Betancourt
Chairman, Environmental Quality Board
P. O. Box 11488
Santurce, Puerto Rico 00910

Honorable Alfonso L. Dávila Silva
Secretary of Agriculture
P. O. Box 10163
Santurce, Puerto Rico 00908

Mr. Rafael Pérez Vega
Executive Director
PR Land Authority
P. O. Box 9745
Santurce, Puerto Rico 00908

Mr. Pedro Gelabert
Director, Caribbean Field Office
Environmental Protection Agency
1413 Fernández Juncos Avenue
Stop 20
Podiatric Center Bldg.
Santurce, Puerto Rico 00909

Mrs. Hilda Díaz de Soltero
U. S. Fish and Wildlife Service
Field Supervisor, Caribbean
Island Office
P. O. Box 491
Boquerón, Puerto Rico 00622

Mr. Humberto Hernández
Director, Soil Conservation Service
G. P. O. Box 4868
San Juan, Puerto Rico 00936

Honorable Basilio Baerga Paravisini
Mayor of Salinas
Box 1149
Salinas, Puerto Rico 00751

STUDY MANAGEMENT TEAM

CESAJ-DS-PD

June 22, 1993

MEMORANDUM FOR THE RECORD

SUBJECT: Río Nigua at Salinas Feasibility Study--SMT Meeting

1. On 23 March 1993 a Study Management Team (SMT) meeting for the Río Nigua feasibility study took place in the Jacksonville District. The meeting was to discuss preliminary plan formulation to be presented at the Technical Review Conference (TRC) that was held 24 March with OCE and SAD representatives in the District. Enclosure 1 provides a list of attendees to the meeting.

2. Reconnaissance Report for Río Nigua was completed in March 1990. The conference on the report was held on 15 August 1990 and the MFR on the conference was approved on 4 October same year. Enclosure 2 is a copy of said MFR.

3. Preliminary plan formulation document and the study schedule to be presented at the TRC were discussed with study team members. Enclosure 3 provides copy of these documents.

4. The following comments regarding plan formulation were made by study team members:

a. Additional topography will be required to design the levee for Coco community. The required information could be collected as part of the survey efforts associated with the geotechnical studies to be performed once a final levee alignment has been selected. Also, Survey Branch could talk with consultants that prepared original topography for the area to explore the possibility of obtaining additional information with a reasonable cost.

b. Real Estate Division representative, Mr. Bealyer, stated that required initial coordination with the PR National Guard for the levee along Coco community was done as part of the reconnaissance study. Final coordination will be done as part of the feasibility study.

c. The need for a debris basin will be addressed as part of the sediments analysis to be performed by WES and is being coordinated by CESAJ-EN-HH as part of scheduled study efforts. A field trip to Salinas and other study areas in Puerto Rico to initiate sediments analysis was scheduled for the week of 29 March 1993. (Note: Field trip took place as scheduled.)

d. Bridge structure at PR Road 154, main entrance to military reservation Camp. Santiago, is a significant obstacle to river flow upstream PR Hwy. 52. Water Stages in the Coco community area closely related to this structure. The impact of replacing this bridge by a more efficient hydraulic structure on proposed levee along the community will be evaluated as part of the improved condition analysis.

e. Based on H&H for existing conditions, proposed ring levee around intersection of PR Highways 52 and 1 will only be required as part of the SPF level of protection. Therefore, alternative plans being considered for the 100-year event will not include this levee.

f. Local government agencies are considering removal of the railroad bridge at Río Nigua, south from the town of Salinas. This structure has a significant impact on water stages in the vicinity. Although the time frame for proposed action is not clear (it could take a few years), existing conditions hydraulics will be revised considering removal of this structure to evaluate its effects on the economics of proposed flood control project.

g. Flood control alternatives will not include features to accommodate the old railroad system.

5. The consensus among study team members was that presented plan formulation was adequate and in harmony with the reconnaissance study results.

4 Encls.

ROBERTO CORTES COLÓN
Study Manager

CF:

SMT members

3/23/93
Rio Nigua at Salinas

name	office	telephone
HANSLER BEALYER	CESAJ-RE	232-1178
PAUL STEVENSON	CESAJ-PD-ER	x2130
RANDY RABB	CESAJ-EN-GS	x3965
Velez Rafael	CESAJ-EN-HH	x 1938
José A. Martínez	CESAJ-DP-PD	8
B. Citron (rep. W. Porter)	CESAJ-PD-ES	X1692
Bob Henderson	EN-DL	2437
JANICE ADAMS	PD-ER	2016
John Hasatak	PD-PB	2232
ROBERTO CORTES	DS-PD	809-729-6893

TECHNICAL REVIEW CONFERENCE

CESAJ-PD-PB 17 March 1993

MEMORANDUM FOR Deputy District Engineer for Project Management
Chief, Engineering Division
Chief, Real Estate Division

SUBJECT: Puerto Rico Studies

1. Reference is made to our memorandum dated 2 March 93, subject Rio Guanajibo, Puerto Rico Feasibility Report In-Progress Review. This confirms that the referenced meeting will be at 0800 on 24 March in Room 930. Also a Technical Review Conference will be conducted for Rio Nigua at Salinas. Existing conditions H&H have been completed, existing condition damages are being calculated. The purpose of the Salinas meeting is to insure intergration of all District elements in the early stages of plan formulation. This meeting will begin at 1300, 24 March in Room 930.

2. A tentative list of participants for the above meetings are as follows:

SAD	OCE
John Cruce	Let Mon Lee
Lillian Almodovar	
Rudy Nyc	
Bert Holler	
Kim Smith	
Bo Crowder	

3. Mr. Jose Martinez, Section Chief of the San Juan Planning Section has requested that technical level discussions for both projects be conducted on 23 March prior to our meetings with SAD and OCE staff to discuss in-depth details of both studies. Accordingly, it is requested that technical staff meet on 23 March at 0830 in Room 226 to discuss details of Rio Nigua at Salinas and at 1300 in Room 226 to discuss Rio Guanajibo. Mr. Roberto Cortes, the Study Manager for each study will also be present.

4. In addition to review of the two General Investigations studies, Study Team Meetings are scheduled for 25 March in Room 226 as follows:

0830	Rio Anton Ruiz
0930	Rio Manati
1030	Rio Fajardo
1300	Rio Loco, Rio Descalabrado, Rio Guamani
1400	El Ojo Agua, Culebrinas, Rio Nigua at Arroyo

5. POC is Mr. John Hashtak, the Puerto Rico Coordinator at X2232.

A. J. Salem

A. J. SALEM
Chief, Planning Division

CESAD-PD-P 2 November 1994

MEMORANDUM FOR RECORD

SUBJECT: Rio Nigua at Salinas, PR - TRC/PFC

1. The subject conference was held 18 October 1994 in Jacksonville District. The purpose of the meeting was to coordinate efforts between the district and division study team members to assure completion of a quality feasibility report/decision document. The conference agenda and list of attendee's are attached as enclosures.

2. Prior to the meeting initiation, Roberto Cortes of the Puerto Rico planning office received a certificate of appreciation for his efforts in completing the Risk and Uncertainty analysis component of the Rio Guanajibo report now under review at WLRC.

3. An overview of the study was provided to include a description of the area's flooding problems and the plan formulation process used in developing alternatives for reducing flood damage in the urban area of Salinas and in the communities of Playa de Salinas and Coco. Planning constraints and a map of the flooded area were provided for discussion (see attachments). Plans being evaluated in detail consists primarily of levee construction, floodway improvement, and bridge replacement. Incremental analysis will be used in assessing the length of levee segments, and Risk and Uncertainty (R&U) analysis used to size levees for Salinas and Coco.

4. District evaluation of the environmental resources in the project area concluded that important fish and wildlife habitat was located at and in the vicinity of the mouth of Rio Nigua and that there were significant cultural resources at the proposed disposal site. District stated that they would formulate plan that minimized impact to fish and wildlife habitat and that they would look at alternative disposal sites. The upper reach of the river where levee and channelization work is being proposed does not contain significant habitat or cultural resources with the exception of an old bridge. If the bridge is to be removed as part of the project mitigation in the form of documenting the structures design and construction methods will need to be prepared.

5. Only about 25% of the excavated material would be used for levee construction. The remainder of the material, most of which also appears to be suitable for levee construction, would need to be disposed of. District stated that the disposal options that they would investigate will include cost effective beneficial uses. These include overbuilding of the levee which is viable in

this case because there are no significant resources in the area, stockpiling of material for use as landfill cover, disposal in disturbed areas of military installation, and disposal at nearby quarry.

6. An Environmental Assessment (EA) will be prepared as part of the study. The EA will assess the effects of sedimentation on the area's environmental resources, excess material disposal, and possible beneficial uses of the material. Incorporation of the EA into the report rather than being a stand alone/separate document will be evaluated by Jacksonville District. A FWS Coordination Act Report is expected in December 1994.

7. The potential for a recreation component will be evaluated. Discussions will be made with the study sponsor to determine the local (municipal) interest in supporting and cost sharing recreation development which is consistent with Policy Guidance Letter No. 36, Recreation Development at (Non-Lake) Structural Flood Control and Harbor Projects.

8. Primary benefits of the project are inundation reduction benefits. Benefits will be estimated for two separable elements, the El Coco Community upstream PR Hwy 52 and the town of Salinas. The town of Salinas area consists of two areas, separated by a parcel of vacant land to the south of the town, the town and the Community Playa de Salinas. An incremental analysis will be conducted for the Playa de Salinas Community by comparing the incremental benefits of protecting Playa de Salinas and the agricultural lands north of the community, separately to the incremental costs of extending the Salinas levee south to the coast. The District will include in the report a cost effectiveness analysis to demonstrate that extending the levee is the least costly alternative for protecting the Playa de Salinas sector as compared to a separate ring levee. The additional benefits associated with protecting the agricultural lands by extending the levee would also be considered. This analysis would help to alleviate any concerns that may arise related to the fact that the extension of the levee would incidentally protect the vacant parcel of land south of the town and thus induce new development in this area. The District was advised not to claim location benefits for this parcel of land since these benefits are difficult to justify and support and growth in the town of Salinas is not expected to be significant during the future years. These benefits are not needed for project justification.

9. An overview of the project's engineering components included a discussion of levee design, interior drainage, bridge replacement, levee material suitability, and a locally constructed concrete embankment within Salinas. Hydraulic analysis indicates that floodway improvements will be required to assure that stages are not increased for the community of Las

Ochenta and other land use activities on the west bank of the river. Analysis also indicates that deepening of the existing channel would require a considerable alteration of the natural river bed which will significantly impact the hydraulic performance and will involve increased maintenance costs associated with sediment transport. Rationale will be provided in the report for the floodway widening as a non-separable element of the levee for eliminating flood damages west of the river (a discussion of this concept is provided as an enclosure to this memorandum). Most of the runoff from the town of Salinas drains away from Rio Nigua. Two outlet structures will be provided for areas adjacent to the channel.

10. Preliminary analysis of material to be excavated from the improved floodway indicates that the material is of good quality for levee construction. The disposal area(s) for excess material must be of adequate size to accommodate materials generated from both construction and maintenance over the life of the project. Initial analysis based on the 100-year levee and floodway design indicates approximately 650,000 CY of excess material (construction only).

11. Risk and Uncertainty (R&U) analysis will be accomplished in the feasibility study. It was agreed that if the with and w/o project condition rating curves are similar, a single rating curve will be used, the without project curve. Single reference points will be used at both Coco and Salinas. The sample size used will be assessed in order to get a representative size in determining the parameters to be used in R&U analysis. The Economics matrix has been modified to include all land uses. A copy of the modified matrix was sent to Dr. Dave Moser, IWR, for his review. CESAD-PD-E requested a copy of the matrix and the District agreed to provide the matrix as soon as possible.

12. The use of a single Real Estate (RE) value vs modification for each alternative levee height will be coordinated with or provided by the District RE office. Real Estate will be addressed in the main report and a RE appendix prepared which will contain sufficient information to serve as a decision document for the recommended plan. The Real Estate appendix will contain maps which delineate the project requirements, indicate interest (estates) required, and also show property ownership lines. A taking analysis should be prepared for any areas impacted by induced flooding to determine if interest is required. The impact of the project, if any, on the abandoned railroad bridge, the quarry road ford, and radio station, should be discussed in the report. On any part of the project area to be used for recreation, a fee estate will be required. The cost of all project areas (even those obtained at no cost) are to be included in the report and the values of all RE are to be based on a Gross Appraisal. The RE appendix will incorporate the RE

values supported by the Gross Appraisal and be based on the RE required for project implementation.

13. Structural data should be presented in the engineering appendix of the feasibility report. If structural DM's are not required, additional design data usually included in a DM should be prepared and presented in the appendix. This would include functional design requirements and technical design criteria for the structural elements of the project to include typical sections of proposed levees, culverts, and drainage or other control structures to the extent possible.

14. The meeting was the first undertaken to implement a cooperative effort in the preparation of a feasibility report, and was considered very successful.

J. Cruce

Encls

John Cruce
CESAD-PD-P

CESAJ-DS-PD June 5, 1995

MEMORANDUM FOR RECORD

SUBJECT: Río Nigua at Salinas, Puerto Rico, Technical Review Conference (TRC)

1. The subject conference was held on 1 June 1995 in Jacksonville District. The purpose of the meeting was to coordinate study plan formulation and evaluation efforts between the District and Division study team members to assure completion of a quality feasibility/decision report. The conference agenda and list of attendees are attached as enclosures 1 and 2, respectively.

2. An overview of the new upcoming technical revision framework for the report, update of District actions with respect to the MFR of the 18 October 1994 TRC and progress report of study were presented and described. This was followed by detailed presentation of final plan formulation process and the recommended plan.

a. This feasibility report will be one of the first to transition from Division to District technical review. Considerable resources has been allocated to this process through the TRCs and District efforts at examining and solving all major technical issues and questions raised. It is of utmost importance that these efforts and technical decision process be properly documented for quality assurance in a Technical Review Document that will accompany the feasibility report. The technical review document is not to duplicate the technical analysis presented in the various supporting appendices included in the feasibility report. Rather, it is to specifically document the answers and decision process of the issues and questions raised during the intra-District and Division TRCs, which are not explicitly presented in the appendices.

b. With respect to the MRF of 18 October 1994 TRC, the following was established:

(1) Refined hydraulics resulted in lower stages.

(2) Final plans evaluated in detail no longer include floodway channel improvements.

(3) Final plans formulated avoided significant impacts to fish and wildlife (no need for mitigation) and provide for borrow and disposal sites with no impacts on cultural resources. Removal of an old unused railroad bridge is assumed to be undertaken by locals well before project is implemented because of existing serious backwater effects in the area.

(4) Excess excavated material will be minimal. Excavation for replacing proposed natural channel conveyance where proposed levee turns into the existing river channel will provide for about 25 percent of the material for construction of levee; the other 75 percent will come from a borrow site located in the National Guard Camp Santiago. With current available soil data, it was assumed that 60 percent of the excavated material will be used for levee construction. When additional soil information becomes available during P&S phase, there is a possibility that the percentage of useful material for construction of levee would increase; thus, further reducing excess excavated materials for disposal.

(5) An environmental assessment (EA) will be prepared as part of the study. It will generally stand by itself as a complete document, but will minimize repetition of information by referencing to other parts of the report. Draft Coordination Act Report from F&WS has been received.

(6) Potential for bicycle and jogging trail on the top of levee will be included in recommended plan. Land for such purpose will be acquired in fee by the local sponsor. This will not significantly change land acquisition because 99 percent of its value would be paid for permanent construction of levee.

(7) In the case of the Salinas town levee, separable incremental economic analysis were conducted for: (1) the spur levee along ramp upstream of bridge on PR Highway 52 to avoid flooding from the 100-year and SPF floods in the northern part of the town, and (2) for extending the town levee in its southern end to protect the Playa area. Both segments were shown to be economically justifiable and the least cost alternative. The District will claim the incidental location benefit in the 132 acres parcel of vacant land between the town and the Playa residential area. The enhancement of this land is an incidental benefit resulting from extending the town levee to protect the Playa residential area. This benefit is considered only under the recommended plan. It was not considered for establishing the optimum size (NED plan) of the various levee heights.

(8) Single reference points were utilized in implementing the risk analysis in the Coco community and the town of Salinas areas. In the area of Coco, the rating curve with and without project is the same while in the area of Salinas they are slightly different. The residential structure sample size was large enough for estimates of socioeconomic parameters within reasonable confidence limits. Complete documentation will be presented in the Economic Appendix. Copies of R&U work sheets for Coco and Salinas town/Playa areas were provided to SAD and Dr. Moser at IWR in November 1994.

(9) Real Estate developed detailed preliminary estimates of each real estate element (land and damages) associated with construction of each of the proposed final plans. The Real Estate Appendix will contain all necessary information and data to serve as a final real estate decision document. A Real Estate Design Memorandum will not be required. A taking analysis will be prepared for the areas where there is potential of induced flooding.

(10) Engineering Appendices will have sufficient data and information including drawings of design, design criteria, project features, and project requirements to allow proceeding directly into Plans and Specifications.

3. Study Update. Study began in summer of 1992. All field work had been completed. During the past two months work concentrated in final plan formulation and identifying the NED plan. There has been continuos participation by the local sponsor in the final plan formulation phase. Inputs for report are about 70 percent complete.

4. Description of Plans. The study area has two separable independent areas: Coco community and the town of Salinas (including the Playa development area). Plan formulation, evaluation, economics, and cost sharing will be presented separately and for both of the areas as a whole in the report. Initial plan formulation included nonstructural measures such as relocation, but it will be very expensive as it requires relocating over 2,500 structures. There are in operation hurricane evacuation and flood warning system plans that are considered complementary to the structural measures suggested under the recommended plan.

a. Coco Community The community would be protected by a 3.94 kilometers levee with an average height of about 3.7 meters (12 feet). The structure will be constructed on lands of Camp Santiago (P.R. National Guard military training area) along the property line bordering the north-west area of the community. Between the proposed levee and the community there is Highway 1 and a 12-meter buffer zone with a security fence (Camp Santiago) and electricity lines that run parallel to the levee alignment. The material for the construction of the levee would be coming from a borrow site within the Camp Santiago. About 30 acres of land would be impacted by proposed levee. No significant impacts on cultural and environmental resources are expected from the implementation of the plan.

b. Salinas town and Playa community area. The urban area south from PR Highway 52 would be protected by a levee with non channel improvements. Downstream from the highway, the levee would be 2.95 kilometers long and an average height of 1.5 meters in the coastal area, 4 meters in the vicinity of the town, and 5 meters in the area north of the town of Salinas. Upstream from the highway, the levee will continue bordering the highway intersection between PR Highways 52 and 1 (spur levee) for about 730 meters with an average levee height of 2.5 meters. PR Highway 1 bridge over Río Nigua would be replaced. The replacement of the bridge on PR Highway 1 will require providing for temporary road access in that area. This temporary improvement will be costed as a separate item in the MCACES. Levee alignment will obstruct existing channel in the vicinity of the PR Highway 1 bridge for a total length of about 500 meters. This segment of channel will be realigned with about same size cross section and slope as the existing channel.

The spur levee along the ramp between PR Highways 52 and 1 is to avoid the 100-year and SPF waters reaching into the northern part of the town. Extending the levee required providing protection to the bridge eastern abutment to maintain the structural integrity of the levee. Protecting the bridge is the least cost alternative for extending the levee in that area. Otherwise, a floodwall under the bridge will have to be constructed.

Though there is no significant induced flooding, a taking analysis will be included in the report. Real Estate will check on the need to acquire and include in the real estate cost interest in the structures and land occupied by several dozen squatters which live within the floodway upstream from bridge on PR Highway 1. Those structures would be removed under the recommended plan.

If the gas station is impacted by the final footprint of the levee alignment, Real Estate Division and Environmental Branch will make sure that tank removal from the gas station is included in the cost estimate and that there is no HTW problem associated with the removal of the tanks.

No significant environmental questions remain regarding the Salinas town levee. The proposed levee has been aligned to avoid the area's ecological resources. The recommended plan contemplates no mitigation component.

Since the flow regimen in the area is not being altered in any significant way, sediment management is not a major O&M element for the proposed project.

5. Project economics. Project sizing and reliability was performed through the risk analysis approach required by EC 1105-2-205. Enclosed tables (see enclosure 3) show results of the analysis and associated stage information. The optimum levee crest elevation for Coco community at cross section 23 is 38.7 meters (NGVD) which would have a 0.33 percent chance of being overtopped in any given year, while the optimum levee crest elevation for the Salinas town/Playa area is 4.5 meters (NGVD) at cross section 2 which would have a 0.01 percent chance of being overtopped in any given year. The NED levee for Coco community would have a 91 percent probability of holding the 100-year event, while the corresponding figure for the Salinas town/Playa NED levee would be 99 percent.

6. Schedule, funding, and coordination. Draft report is scheduled for September 30, 1995, and although funding is limited, every effort will be made to complete report within the available funding

Regarding the FRC, the possibility of holding it in Jacksonville should be explored if there is no significant pending issue. Only key management people should assist.

When report is submitted to SAD, simultaneous public coordination should be initiated if there are no significant policy issues pending. The PMP should clearly show the logistic and management for the different tasks and efforts that the District will undertake for the plans and specifications phase of the project.

7. Concluding remarks. The District has completed significant work since the last TRC on 18 October 1994. All pending questions and issues remaining have been addressed and resolved. At this moment, there is no significant technical and environmental issue relating to the proposed plan for Coco community and the Salinas/Playa area. District shall make all necessary efforts to complete draft report and technical review document by 30 September 1995.

Encls. 3

JOSE A. MARTINEZ
Chief, Planning Section

RIO NIGUA AT SALINAS, PUERTO RICO
PLAN FORMULATION/TECHNICAL REVIEW CONFERENCE
1 JUNE 1995
JACKSONVILLE, FLORIDA
ROOM 930

AGENDA

1030 - 1040	Welcome and Introductions	Mr. Strain
1040 - 1100	Meeting Objectives Technical Review and Quality Assurance	Mr. Mc Govern
1100 - 1130	Study Update and Status	Mr. Martinez
1130 - 1230	Lunch	
1230 - 1430	Study Components Plan Formulation/ Alternative Evaluation H&H, Design, and Cost Estimates Geotechnical Real Estate Environmental Project Economics Risk Analysis NED Plan Determination Environmental Concerns	Mr. Cortes
1430 - 1500	Wrap-up Schedule and Funds Conclusion	
1500	Adjourn	

RIO NIGUA AT SALINAS
TECHNICAL REVIEW CONFERENCE
JACKSONVILLE, FLORIDA

1 JUNE 1995

LIST OF ATTENDEES

NAME	OFFICE	TELEPHONE
Roberto Cortés Colón	Planning Section. DS-PD	(809) 729-6893/6895
Alberto Gonzalez	PD-PB	904-232-2459
Lillian Alcaddvar	CESAD-EP-PE	404-331-4327
John Cruce	CESAD-EP-PL	404-331-4326
Angie Premo	CESAD-PM-C	404 331-3882
Randy Rabb	CESAJ-EN-GS	904-232-1885
Eric Raasch	CESAJ-PD-D	904-232-3680
George Strain	CESAJ-PD-A	904-232-2239
Frank McGovern	CESAD-EP-P	404 331-6701
Jose A. Martinez	CESAJ-DS-PD	(809) 729-6893
Bo Crowder	CESAD-RE-C	(404) 331-6760
Eric Holand	CESAJ-EN-HH	(904) 232-2108
Velez, Rafael	CESAJ-EN-HH	(904) 232-1938
Kaiser Edmund	CESAD-EN-HW	(404) 331-6734
Barbara Cintrón	CESAJ-PD-ES	(904) 232-1692
Bob Henderson	CESAJ-EN-DL	(904) 232-2437
Phil Sylvester	EN-HI	(904) 1142
Manuel Perez	CESAJ-EN-C	904-232-1967
Cindy Turner	CESAJ-RE-A	904-232-1851

COMMUNITY MEETING

CESAJ-DS-PG

October 19, 1992

MEMORANDUM FOR RECORD

SUBJECT: Río Nigua at Salinas Public Meeting

1. The first public meeting of the Feasibility Study for Río Nigua was held on August 11, 1992, in the Municipality of Salinas assembly room. The meeting was chaired by LTC Stephen R. Benton, DDE for the Antilles, and Eng. Hilton Miró Detrés, Assistant Secretary for Flood Control, Department of Natural Resources. The activity was coordinated with municipal authorities and publicity for the activity was through fliers, the local newspaper, and radio. Letters to local and federal agencies and local officials in general were sent providing information on the meeting (see enclosed mailing list). The meeting was recorded and there was good participation from the public in general. A meeting summary was prepared and is part of the record.

2. In general, the meeting was informative and there is consensus about the urgent need for the flood control project.

3. Main concerns expressed in the meeting are related to the agonies of living in an flood prone area. Most of the participants were impacted (in a negative way) by the time frame required for the development of the Corps' project. People in the audience requested assistance from the Corps in getting something (anything) done to solve the immediate need for flood protection.

4. There was a consensus about the problems that the old railroad bridge is creating during floods within the developed areas south of the town. This old structure is no longer in use, and its current structural conditions is a potential safety hazard to the community, particularly during floods. There was a vivid request to the Department of Natural Resources (DNR) to remove that structure ASAP. However, there are plans, see enclosed record, to use the railroad system as part of a main tourist program for the south-east cost, "Tren del Sur". The old bridge will have to be replaced as part of the proposed transportation program and to improve channel conveyance as part of the proposed flood control project. This structure should be removed as part of an effective maintenance program that should be implemented by DNR with the possible assistance of the P. R. National Guard (see enclosed letter) in the area.

5. The following is a general presentation of issues presented by functional areas:

a. Engineering. The old railroad bridge south of the town will have to be replaced for future use. Therefore, channel conveyance will be significantly improved. This work (the cost) may not be required as part of the flood control project. In the design of the flood gate required as part of the levee alternative, it should be considered that the user of the railroad will consist of a slow moving engine with the only purpose of site seeing. The possibilities of having this tourist attraction running during extraordinary rainfall events are minimal.

b. Plan formulation. There is a lot of interest in providing protection to the developed areas on the west bank and some rural areas upstream from the proposed project site. The benefit to cost ratio and the incremental analysis requirements may be main limitations to this particular request.

c. Environmental. As part of the project presentation, the public was notified that an environmental impact study and report was going to be prepared as part of the total study effort. No issues or concerns were presented at the public meeting.

3 Encls

ROBERTO CORTES COLON
Project Manager

CF:

CESAJ-PD-PB

CESAJ-PD-E

Eng. Hilton Miró, DNR

RIO NIGUA AT SALINAS FLOOD CONTROL STUDY

PUBLIC MEETING SUMMARY
August 11, 1992

The meeting began at 7:45 p. m. and was conducted in Spanish. It took place at the facilities of the Municipality of Salinas Assembly. There was a participation of approximately 84 persons from the Salinas community.

The public meeting was co-chaired by LTC Stephen R. Benton, U. S. Army Corps of Engineers; Eng. Roberto Cortés, representing Mr. José A. Martínez Laboy, Chief, Planning Section, U. S. Army Corps of Engineers; and Eng. Hilton Miró, Assistant Secretary for Flood Control, Department of Natural Resources.

Other members of the U. S. Army Corps of Engineers present at the meeting were: Mrs. Elsa Jiménez, Public Affairs Office; Eng. Edil Rosas, project manager for the Río Nigua at Salinas study; and Mrs. Lucy Soto, secretary, who was the person taking notes of the meeting.

Eng. Roberto Cortés gave a brief introduction explaining the purpose and procedures of the public meeting and informing the public that the same was being recorded as part of our records. LTC Benton addressed the public in Spanish. Eng. Cortés introduced Eng. Hilton Miró, representing the Department of Natural Resources, who also addressed the public. Eng. Miró welcomed the public in behalf of the Secretary of the Department of Natural Resources and on his own, and then explained the purpose of his presence.

Eng. Cortés then asked all persons who were representing a government agency to acknowledge their presence. Present at the meeting were: Mr. Edgar Fuentes, Special Assistant to the Secretary of Agriculture; Mr. Miguel Rodríguez, Budget and Management Office; Mr. Antonio Vázquez Rodríguez, Puerto Rico Police Department; Mr. David Carrión, Puerto Rico National Guard; Mr. Jesús F. Lebrón, Regulations and Permits Administration, Guayama Region; and Mr. Cony Alvarado, Director, Salinas Civil Defense.

Eng. Cortés explained the public the Corps of Engineers study process. He indicated that the Río Nigua t Salinas reconnaissance phase was completed in May 1990. The local funds to initiate the feasibility phase were received in March 1992. He stated that this phase is an extensive and detailed one. The draft feasibility report for Río Nigua is scheduled to be completed by 1995. In this phase, various structural and nonstructural alternatives will be considered for flood control in this area. The decision-making process to choose the final alternative is very complex and in which the Department of Natural Resources plays an important role. He clearly established that one of the parameters which define the reach of the study is based in its economic justification.

Eng. Cortés introduced Eng. Edil Rosas, who is the engineer mainly responsible for this study. Eng. Rosas explained to the public in detail the alternatives being considered for the study.

Once Eng. Rosas concluded his presentation, the public was given the opportunity to comment on the subject.

The persons were asked to reach the microphone, give their names, and make a brief comment so that as many people as time would allow could have the opportunity to express themselves.

Those persons who gave their opinions were: Mr. José Alvarado; Mr. Cony Alvarado, Director Civil Defense; Felicita Llovet, President of the Municipal Assembly; Carmelo Echevarría; Mr. Luis E. Caraballo; Mr. Marta M. Ortiz; Mr. Ramón A. Báez; Mrs. Dolores Izquierdo; Mr. Felipe Díaz Delgado; Mrs. Tata Santiago; Mr. Angel Luis Ortiz Luna; and Mr. Damián González.

The following is a summary of the major concerns expressed by these persons (for detailed information on each person's expressions, please refer to recorded tapes of meeting):

--In which way could the Puerto Rico Government, the U. S. Army Corps of Engineers, or any other organization or agency help them mitigate in a short term period the impacts from the Río Nigua floods.

--Most of the concerns were related to the construction schedule. The study sounds very reassuring, but the waiting time to have the whole study concluded and project built seems too long.

--The lack of maintenance of the existing channel by the pertinent agencies.

--Which areas will be protected by the project? What properties or families will have to be relocated?

--The project should contemplate protection to the Sabana Llana area, upstream from current project site.

Mrs. Tata Santiago, member of Margarita Community Committee and staff member of the Salinas Hoy newspaper, was asked to serve as point of contact for the community of Salinas. Mrs. Santiago's address and telephone number are: Box 467, Salinas, Puerto Rico 00751; (809) 824-0681.

Due to lack of time, there were some persons who were not able to express their concerns.

The meeting adjourned at 9:40 p. m.

Prepared by:

Lucy Soto, Secretary
U. S. Army Corps of Engineers

CESAJ-DS-PD 29 May 1996

MEMORANDUM FOR RECORD

SUBJECT: Río Nigua at Salinas Community Meeting

1. Subject meeting was held on Thursday, May 23, 1996, at the Angel Luis "Cholo" Espada Coliseum in the town of Salinas. Meeting started at 7:20 p.m. and ended at 8:30 p.m.

2. Meeting was chaired by LTC Chester D. Fowler, representing the COE, and by Eng. José Arroyo, representing the Secretary of the DNER. Eng. Roberto Cortés presented the study results.

3. Records show the attendance of 58 persons. Present at the meeting also were: Hon. Basilio Baerga, Mayor of Salinas; Mr. José Dávila, Aide to the Governor; Hon. José E. Meléndez, Senator for the town of Salinas; Acting Director for the DNER Guayama Region; Director of the Civil Defense; a representative of the PR Planning Board; and a representative of the Management and Budget Office.

4. Study results were presented to the community by Eng. Roberto Cortés Colón. Eng. Cortés Colón pointed out very clearly all measures that were taken to avoid or minimize environmental impacts. He mentioned that by all means measures to avoid impacting the Coastal Barrier Zone along the river mouth were observed.

5. Attendants' participation making questions to clarify their doubts about the project was good. Major concern among residents from La Margarita area was the removal of the old (abandoned) train bridge. They expressed their desire to have the rail removed because it poses a serious flood and safety hazard.

6. They also expressed their desire to have the project built as soon as possible.

7. No environmental issues or concerns were raised during the meeting.

8. The meeting was recorded. A detailed summary of it will be prepared by the undersigned by mid June 1996.

LUCY SOTO
Secretary, Planning Section

RIO NIGUA AT SALINAS, PUERTO RICO
FEASIBILITY REPORT

APPENDIX E
REAL ESTATE PLAN

TABLE OF CONTENTS

LIST OF PLATES

9/96 (rev)

APPENDIX E

REAL ESTATE PLAN

1. **STATEMENT OF PURPOSE**

This Real Estate Plan (REP) is tentative in nature for planning purposes only; both the final real property acquisition lines and the real estate cost estimates provided are subject to change even after approval of the Rio Nigua at Salinas Feasibility Report.

2. **AUTHORIZATION**

This study was authorized by a resolution adopted by the Committee on Public Works and Transportation, United States House of Representatives on October 1, 1986, in response to a request by the Puerto Rico Resident Commissioner in Washington D.C. in a letter dated June 19, 1985. The Department of Natural Resources (DNR) is the local sponsor for the project.

In compliance with the above authorization, a Reconnaissance Report on Rio Nigua at Salinas was completed and approved on September 24, 1990.

3. **PROJECT LOCATION**

Puerto Rico is located approximately 1,600 miles southeast of New York City and approximately 1,000 miles east of Miami, Florida. It is the smallest of the Greater Antilles island chain, measuring approximately 100 miles by 35 miles.

The Rio Nigua study area is located on the south coast of Puerto Rico, approximately 21 miles east of Ponce. The headwaters of the Rio Nigua originate in the Cordillera Central, near the town of Cayey, at an elevation of about 2,821 feet. The river then enters the upper coastal area through the Camp Santiago National Guard Base, to the west side of the rural community of Coco and flows toward the southwest, passing west of the town of Salinas, to discharge into the Caribbean Sea.

The town of Salinas is located on the south coast of Puerto Rico, approximately mid-way between Guayama (to the east) and Ponce (to the west), and approximately 45 miles southwest of the San Juan metropolitan area.

4. **PROJECT DESCRIPTION**

Refer to Plates A-3 through A-5, Real Estate Planning Map, Exhibit A, Borrow Area Location Map, and Exhibit B, Disposal Area Location Map.

The recommended plan provides flood protection to the populated areas of Salinas and Playa de Salinas. Flood protection is accomplished by levee and channel segments lying east of the Nigua riverbed between the existing channel and the populated areas. Where the levee alignment shifts to within the existing riverbed, additional realty requirements are needed for the channel to be realigned to the west of the levee.

The Coco levee begins from a point northwest of the Community of Coco. This portion of the levee system contains a segment within the Federally owned Camp Santiago Military Reservation. The Camp Santiago levee segment runs east of the Nigua riverbed, parallel and contiguous to P.R. 1 along the eastern border of the Camp Santiago property, terminating at the intersection of P.R. 154 and P.R. 1. The second levee segment on the upstream side (north) of P.R. 52 runs (east-west) from the raised P.R. 52 right-of-way and Nigua riverbed intersection along the north side of the P.R. 1 entrance ramp (onto P.R. 52) northeast to the intersection of P.R. 1 and P.R. 154. The levee then crosses P.R. 1 and continues along the south side of the P.R. 154 right-of-way to where it ties into the raised P.R. 52.

The Salinas levee begins south of P.R. 52. This levee runs north-south to the Caribbean Sea. It lies east of the Nigua riverbed and contiguous to the west of several densely populated residential subdivisions. P.R. 1 intersects the levee approximately mid-way between P.R. 52 and the Caribbean Sea. To avoid relocating homes, the levee is diverted slightly west to within the existing riverbed between Station 20+00 and Station 8+00. The channel is realigned contiguous to the west of the levee throughout this reach, until reconnecting to the natural channel at Station 8+00. From Station 8+00, the levee runs generally south to the sea.

There is a 50 acre borrow area in a hilly portion of Camp Santiago (on Federal land) required for a period of three years. Refer to Paragraph 5. Government-Owned Land on page E-3.

The disposal area is 25 acres in size and is required for a period of three years. It is located approximately 1/4 of a mile west of the Nigua riverbed's intersection with P.R. 52. The area is irregularly shaped and is contiguous to the south of the P.R. 52 right-of-way. Access to the disposal area is by graded roadway. The area is proposed to be restored to pre-project condition at easement expiration.

There will be an unpaved access road extending from the west bank of the Nigua River at P.R. 1 north along the west side of the riverbed, tying into an existing road. This road will provide access to the disposal area and other points between P.R. 1 and P.R. 52 which will be cut off by levee construction. The access road is approximately 1.54 kilometers long. There are to be three permanent road rampings associated with the project. The first is located at the intersection of the Nigua riverbed and P.R. 1 where the bridge will be replaced, the second is downstream at Station 6+00 and will provide access to the 60+ acre coastal area where the existing access road will be blocked by the proposed levee. The third ramp is on P.R. 1, upstream P.R. 52. There is a temporary road easement required for one year during construction of the new P.R. 1 bridge.

5. GOVERNMENT-OWNED LAND

Most of the Coco levee, located north of P.R. 52, will be on Federal lands (approximately 32.88 acres) at Camp Santiago National Guard Military Reserve. The borrow area, consisting of 50 acres, is also located at Camp Santiago. The National Guard has agreed to make these lands available for project purposes.

The lands needed for the Coco levee will be granted to the Local Sponsor upon request, as a perpetual flood protection levee easement.

A license will be issued to the Local Sponsor for a period of three years for access to the borrow area and removal of sand, gravel and dirt to be used in construction of the flood protection levees. Generally a cost would be charged to the licensee, but in this instance a waiver of charges will be requested. A borrow area easement estate is included in this report in the event a document other than a license is utilized.

6. SPONSOR-OWNED LAND

The existing riverbed of the Nigua River is owned by the Department of Natural Resources of the Commonwealth of Puerto Rico, the proposed local sponsor for this project. The affected riverbed lands consist of approximately 11.64 acres.

7. ATTITUDE OF OWNERS

Coordination of the Feasibility Report was accomplished through numerous formal and informal meetings with various Commonwealth and Federal agencies, municipality officials, various interested groups, and the residents of the floodplain. The residents of the project area have generally expressed acceptance and support of the recommended plan.

8. TAKINGS ANALYSIS

It has been determined that project implementation will cause no significant increase in frequency or duration, but there will be an increase in depth. Even so, areas where the increased depth of flooding will occur is mountainous and, accordingly, there will be a rapid runoff of the increased depth of water. Additionally, the area to be impacted is undeveloped and there is no economic benefit presently being obtained from this area. Under these circumstances, the increased depth of flooding would cause no damage to the real property. A takings analysis prepared September 12, 1995, concluded that "...not even slight damage is inflicted upon private property. That while conceding that there will be greater flood depths, it is denied that the greater depths will cause any damage... the increased flooding caused by the project will not constitute a taking under the Fifth Amendment of the United States Constitution."

9. **APPRAISAL INFORMATION**

Refer to Real Estate Planning Map, Plates A-3 through A-5, Borrow Area Location Map, Exhibit A and Disposal Area Location Map, Exhibit B.

The neighborhoods affected by the project features include Camp Santiago Military Reserve, north of P.R. 52 and west of P.R. 1; the Community of Coco, east of P.R. 1 and north of P.R. 52; the western portion of the Town of Salinas, south of P.R. 52, and the residential section of Playa de Salinas (Salinas Beach) community. Land uses include the Camp Santiago National Guard Military Reserve and its various functions; commercial where the riverbed crosses P.R. 1; agricultural/grazing southeast of Coco and west of Salinas; and residential (oceanfront) where the flood control system meets the Caribbean Sea in Playa de Salinas.

There are three land classifications included within the proposed acquisition. The majority of the acquisition includes portions of the large grazing tracts along the existing riverbed. There are commercial tracts to be partially acquired where the project features intersect P.R. 1 near Station 13+00. There are four residential oceanfront parcels to be acquired on the extreme south end of the project where the levee ties into the beach. These homesites are not delineated as subdivided lots on the tax parcel maps, however, the appraiser assumed they are separate fee simple ownerships and have simply not been recorded as such on the tax maps, which is not uncommon in Puerto Rico. There is no prime or unique farm land within the project.

Coco Levee:

Approximately 32.88 acres of the lands required for the Coco levee are within the Federal Camp Santiago Military Reservation and are valued at $66,760. The portion of the Coco levee is .61 of an acre levee spur which extends south of P.R. 1 to the north of P.R. 52 and to the west of P.R. 154. This portion of the Coco levee is within a privately owned grazing tract and is valued at $1,220.

Salinas Levee:

The land requirements for the Salinas levee include approximately 27.39 acres, of which approximately 11.64 acres lie within the existing riverbed having a zero value. The balance, approximately 15.75 acres, is valued at $332,420.

The improvements within the Salinas levee footprint include a farm residence in poor condition, a radio station office building, a service station and four waterfront residential dwellings located where the levee ends at the beach. The improvements are valued at a total of $335,100.

Channelization:

The Salinas levee was moved west to within the existing riverbed between Stations 20+00 and 8+00 to avoid the acquisition/relocation of several homes. This channel improvement will divert the water in a path contiguous to the west of the levee in this area. The permanent channel improvement easement consists of approximately 16.19 acres within agricultural/grazing ownerships, at an estimated value of $32,056. There are also approximately 30 squatter structures within the diversion channel footprint that are valued at a total of $60,000.

Borrow Area:

The borrow area consists of approximately 50 acres in a hilly portion of Camp Santiago. This is on Federal land and is valued at $99,000.

Disposal Area:

The disposal area consists of approximately 25 acres, lies within one large agricultural tract, and is required for a period of three years. It is located approximately 1/4 of a mile west of the Nigua riverbed's intersection with P.R. 52. The area is irregularly shaped and is located contiguous to the south of the P.R. 52 right-of-way. Access to the disposal area is by graded roadway. The area will reportedly be restored as closely as possible to its pre-project condition at the expiration of the easement. The estimated temporary easement value is $13,500.

Road Requirements:

The temporary road requirement for rebuilding the P.R. 1 bridge is one year. The area required outside of the existing road right-of-way consists of approximately .09 of an acre within a commercial tract fronting P.R. 1. The temporary easement value is $1,176.

The project plan also includes two permanent road easements. There would be an unpaved road extending from the west bank of the Nigua River at P.R. 1, north along the west side of the riverbed to the disposal area and other points west of the levee/channel where access will be cut off by the project. The road consists of approximately 1.9 acres within agricultural tracts and is valued at $3,762. The second permanent road consists of .5 of an acre road ramp associated within the widening of P.R. 1 onto the new bridge. The area is within the commercial parcels along the south side of P.R. and is valued at $64,687.

A road ramp over the levee at Station 6+00 to provide access to points west of the levee and south of P.R. 1 will be acquired in fee. The ramp area outside of the levee acquisition consists of approximately .5 of an acre within an agricultural/grazing tract and is valued at $1,000.

Staging Areas:

All construction staging will be accomplished within areas to be acquired for project features. No additional lands are needed.

Severance Damages and Benefits:

The project acquisition includes the partial acquisition of 13 non-Federal parcels. Most of the tract remainders are large enough and accessible so that it is obvious that they are not damaged by lost access or downgraded highest and best use. The areas that required closer scrutiny are large enough in all cases to be used as homesites. No severance damages are assigned to the tract remainders.

The special benefits applicable to the protected tract remainders are not measurable from the available market data. Therefore, there may be no offset against either the severance damages (Commonwealth Rule) or the entire just compensation award (Federal Rule). Lands and damages value estimates are identical under both the Commonwealth and Federal Rules of Appraisal.

10. RELOCATION ASSISTANCE (PUBLIC LAW 91-646)

There are approximately five owner occupied residential structures to be acquired, 30 squatter structures to be removed, and two businesses that are eligible for relocation assistance. Estimates of costs to comply with Public Law 91-646 total $340,000. This estimate includes costs for moving and restablishment expenses for the affected businesses, and moving and other costs for providing the displaced families with comparable decent, safe and sanitary replacement housing.

Availability of Replacement Housing: During a field visit to the project area, it was determined that there is adequate and suitable replacement housing available for the families affected by the project.

11. **ACQUISITION/ADMINISTRATIVE COSTS**

The following acquisition/administrative cost estimates are based on the acquisition of land and structures within 21 ownership tracts (of which one is federal) and 37 structures, as determined by area tax maps and field investigations of the project area.

Federal Acquisition/Administrative Cost Estimate:

Project Planning	$ 20,000
Review of Acquisitions (51 @ $2,000 ea)	102,000
Review of Appraisals (50* @ $1,500 ea)	75,000
Review of Condemnations (est of 6 @ $2,500 ea)	15,000
Review of PL 91-646 (37 @ $500 ea)	18,500
Review of Temporary Permits (Rights-of-Entry)	2,000
Draft PCA Review by Real Estate	2,000
Total Federal Acquisition/Administrative Cost:	**$234,500**

Non-Federal Acquisition/Administrative Cost Estimate:

Acquisitions (51 @ $5,000 ea)	$255,000
Appraisals (50* @ $3,000 ea)	150,000
Condemnations (est of 6 @ $10,000 ea)	60,000
PL 91-646 Assistance (37 @ $1,000 ea)	37,000
Temporary Permits (Rights-of-Entry)	4,000
Damage Claims	3,000
Total Non-Federal Acquisition/ Administrative Cost:	**$509,000**

*The Federal ownership requires no appraisal.

12. **RELOCATIONS OF ROADS, BRIDGES, UTILITIES, TOWNS AND CEMETERIES**

There are no towns or cemeteries to be relocated due to project implementation.

Construction of the proposed flood control project will require replacement of the P.R. 1 bridge and enlargement of the existing channel. There are two water lines (4 and 2 inches) that will be affected by the bridge replacement. From the bridge to the coastal area, is a significant number of electrical power lines that will need to be relocated. In the vicinity of the same bridge, there are telephone lines that need to be relocated.

Downstream from P.R. 52, about 350 meters, is a 130 meters long siphon that is part of the irrigation system of the area that will have to be modified to accommodate the proposed plan.

All utility relocations will be done within lands required for the project.

An Attorney's Report of Compensable Interest dated September 14, 1995, prepared for this project concludes that "...a compensable interest has been established for the replacement of the P.R. 1 bridge together with the water, electric and telephone lines. There is insufficient evidence to conclude whether or not a compensable interest exists for the siphon." This issue will be resolved prior to project crediting.

There is an abandoned railroad bridge located south of PR Highway 1 bridge that will be removed for project purposes. An Attorney's Opinion of Compensibility will be prepared to document that this bridge is indeed abandoned. In accordance with Project Guidance Memorandum (PGM), if a substitute facility is constructed, the owners rights will be subordinate to the operation of the project.

13. NON-FEDERAL OPERATION/MAINTENANCE RESPONSIBILITIES

In accordance with the proposed Project Cooperation Agreement (PCA), the local sponsor shall maintain and operate the project after completion pursuant to the directions of the U.S. Government.

14. LOCAL SPONSOR'S AUTHORITY TO PARTICIPATE IN THE PROJECT

The Department of Natural Resources of the Commonwealth of Puerto Rico is the local sponsor for the majority of the flood control projects in Puerto Rico. It has provided all lands required to date for the on-going Portugues and Bucana Flood Control Project since 1974. The Department of Natural Resources has also provided all necessary lands for the Sabana Grande Project completed in 1990, and for the Rio Cibuco Project at Vega Baja, Puerto Rico.

The Department of Natural Resources contracts directly for surveys, title evidence and appraisals and generally utilizes other Puerto Rican agencies for the acquisition effort, such as the Puerto Rican Highway Authority. There is a team similar to the Corps' Life Cycle Project Management Division which administers the different on-going and major authorized flood control projects in the planning stage.

All condemnations are handled by the Puerto Rican Department of Justice in the local Puerto Rican courts. Condemnation assemblies are prepared by counsel for the agency which is under contract with the Department of Natural Resources to acquire lands. Puerto Rican law provides for condemnation of right-of-entry for survey and exploration during the planning stages. In condemnation for title, there is a 90-day period after an order or possession is filed before the owner is required to vacate the property.

15. **HAZARDOUS, TOXIC AND RADIOACTIVE WASTES (HTRW)**

A preliminary assessment was conducted in May 1993, to address the existence or potential for occurrence of HTRW contamination on lands, including structures and submerged lands. The preliminary assessment for the project/study included a project review, site literature/document review, and site reconnaissance, with negative results

16. **OUTSTANDING RIGHTS**

There are no known outstanding rights other than easements for public roads and utilities.

17. **MINERALS**

There exist no minerals in the project area which require valuation.

18. **STANDING TIMBER AND VEGETATIVE COVER**

There is no standing timber or vegetative cover that has significant economic, recreation or scenic value. There is no "prime or unique" farmland within the project area.

19. **MITIGATION**

There are no wetlands affected by the project that require a mitigation feature.

20. **SUMMARY OF ESTIMATED PROJECT REAL ESTATE COSTS**

Lands and Damages:

Lands (143.42 acres total)	
Fee (0.50 acres)	$ 1,000
Easements :	
Flood Prot Levee (16.36 acres)	333,640
Channel Imp (16.19 acres)	32,056
Permanent Road (2.40 acres)	68,449
Temporary Road (.09 acre)	1,176
Temporary Disposal (25.00 acres)	13,500

Federal Lands:		
Coco Levee (32.88 acres)	66,760	
Borrow Area (50.00 acres)	99,000	
Subtotal		$615,581
Improvements:		395,100
Severance Damages:		0
Minerals		0
Total Lands and Damages (Rounded)		$1,010,000
Acquisition/Administrative Costs		
Federal:		234,500
Non-Federal:		509,000
Public Law 91-646 Payments		340,000
Contingencies (25%)* (Rounded)		524,000
Total Estimated Real Estate Costs (RD)		$2,617,000

*A contingency of 25% is estimated to cover uncertainties associated with such elements as valuation variance, negotiation latitude, condemnation awards and interest, and refinement of boundary lines during ownership verification.

21. ESTATES TO BE ACQUIRED

Fee: The fee simple title to (the land described in Schedule A) (Tracts Nos. ___, ___ and ___), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Flood Protection Levee Easement: A perpetual and assignable right and easement in (the land described in Schedule ___) (Tracts No. ___, ___ and ___) to construct, maintain, repair, operate, patrol and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Channel Improvement Easement: A perpetual and assignable right and easement to construct, operate, and maintain channel improvement words on, over and across (the land described in Schedule A) (Tracts No. ___, ___ and ___) for the purposes as authorized by the Act of Congress approved __________, including the right to clear, cut, fell, remove and dispose of any and all timber, trees, underbrush, buildings, improvements and/or other obstructions therefrom; to excavate, dredge, cut away, and remove any or all of said land and to place thereon dredge or spoil material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Temporary Borrow Area Easement: A temporary easement and right-of-way in, on, over and across (the land described in Schedule ____) (Tracts No. ___ and ___), for a period not to exceed _____ year(s), beginning with date possession of the land is granted to the (Project Sponsor), for use by the (Project Sponsor), its representatives, agents, and contractors as a borrow area, including the right to borrow and/or deposit fill, spoil and waste material thereon and to perform any other work necessary and incident to the construction of the _________________ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Temporary Disposal Area Easement: A temporary easement and right-of-way in, on, over and across (the land described in Schedule ___) (Tracts No. ___ and ___), for a period not to exceed _____ year(s), beginning with date possession of the land is granted to the (Project Sponsor), for use by the (Project Sponsor), its representatives, agents, and contractors as disposal area, including the right to borrow and/or deposit fill, spoil and waste material thereon and to perform any other work necessary and incident to the construction of the _______________ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Permanent Road Easement: A perpetual and assignable easement and right-of-way in, on, over, and across (the land described in Schedule ___) (Tracts No. ___ and ___) for the location, construction, operation, maintenance, alteration and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell, remove, and dispose of any and all timber, trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way and use the surface of the land as access to their adjoining land); subject, however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

Temporary Road Easement: A temporary and assignable easement and right-of-way in, on, over, and across the land for a period not to exceed ____ year(s), for the location, construction, operation, maintenance, alteration, replacement and use of an access road and appurtenances thereto; together with the right to plant thereon trees, grass, shrubs and protect and control vegetation, to trip, cut, fell, remove, and dispose of any and all timber, trees, underbrush, obstructions, and other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the owners, their heirs and assigns, the right to use the surface of the land as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

22. REAL ESTATE ACQUISITION SCHEDULE

According to the draft Project Management Plan (PMP), land acquisition is tentatively scheduled for initiation in 1999 with construction beginning in 2001. Construction will take approximately two years to complete. These dates are preliminary and are subject to change.

23. REAL ESTATE PLANNING MAP

The real estate planning map is included as Plates A-3 through A-5. The Borrow Area Location Map is included as Exhibit A and the Disposal Area Location Map is included as Exhibit B.

25. CHART OF ACCOUNTS

As requested by Planning Division, the project real estate costs in the MCACES format are shown below as total project costs, cost for the Salinas Levee, cost for the Coco Levee and cost for the Borrow and Disposal Areas.

Rio Nigua at Salinas-Total Project

01	LANDS AND DAMAGES	
01A00	PROJECT PLANNING	$ 20,000
01B--	ACQUISITIONS	
01B20	BY LOCAL SPONSOR (LS)	255,000
01B40	REVIEW OF LS	102,000
01C--	CONDEMNATIONS	
01C20	BY LS	60,000
01C40	REVIEW OF LS	15,000

01E--	APPRAISALS		
01E30	BY LS		150,000
01E50	REVIEW OF LS		75,000
01F--	PL 91-646 ASSISTANCE		
01F20	BY LS		37,000
01F40	REVIEW OF LS		18,500
01G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY		
01G20	BY LS		4,000
01G40	REVIEW OF LS		1,000
01G60	DAMAGE CLAIMS		4,000
01M00	PROJECT RELATED ADMINISTRATION		
	REAL ESTATE REVIEW OF PCA		2,000
01R--	REAL ESTATE PAYMENTS		
01R10	LAND PAYMENTS		
01R1B	BY LS		1,010,000
01R2	PL 91-646 ASSISTANCE PAYMENTS		
01R2B	BY LS		340,000
TOTAL REAL ESTATE COST EXCLUDING CONTINGENCY			$2,093,500
TOTAL REAL ESTATE CONTINGENCY COST		$524,000	
TOTAL PROJECT REAL ESTATE COST			$2,617,000

Rio Nigua at Salinas-Salinas Levee

01	LANDS AND DAMAGES	
01A00	PROJECT PLANNING	$ 15,000
01B--	ACQUISITIONS	
01B20	BY LOCAL SPONSOR (LS)	240,000
01B40	REVIEW OF LS	96,000
01C--	CONDEMNATIONS	
01C20	BY LS	60,000
01C40	REVIEW OF LS	15,000
01E--	APPRAISALS	
01E30	BY LS	144,000
01E50	REVIEW OF LS	72,000
01F--	PL 91-646 ASSISTANCE	
01F20	BY LS	37,000
01F40	REVIEW OF LS	18,500

01G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY		
01G20	BY LS		2,000
01G40	REVIEW OF LS		1,000
01G60	DAMAGE CLAIMS		1,000
01M00	PROJECT RELATED ADMINISTRATION		
	REAL ESTATE REVIEW OF PCA		2,000
01R--	REAL ESTATE PAYMENTS		
01R10	LAND PAYMENTS		
01R1B	BY LS		830,200
01R2	PL 91-646 ASSISTANCE PAYMENTS		
01R2B	BY LS		340,000
TOTAL REAL ESTATE COST EXCLUDING CONTINGENCY			$1,873,000
TOTAL REAL ESTATE CONTINGENCY COST		$468,000	
TOTAL PROJECT REAL ESTATE COST			$2,342,000

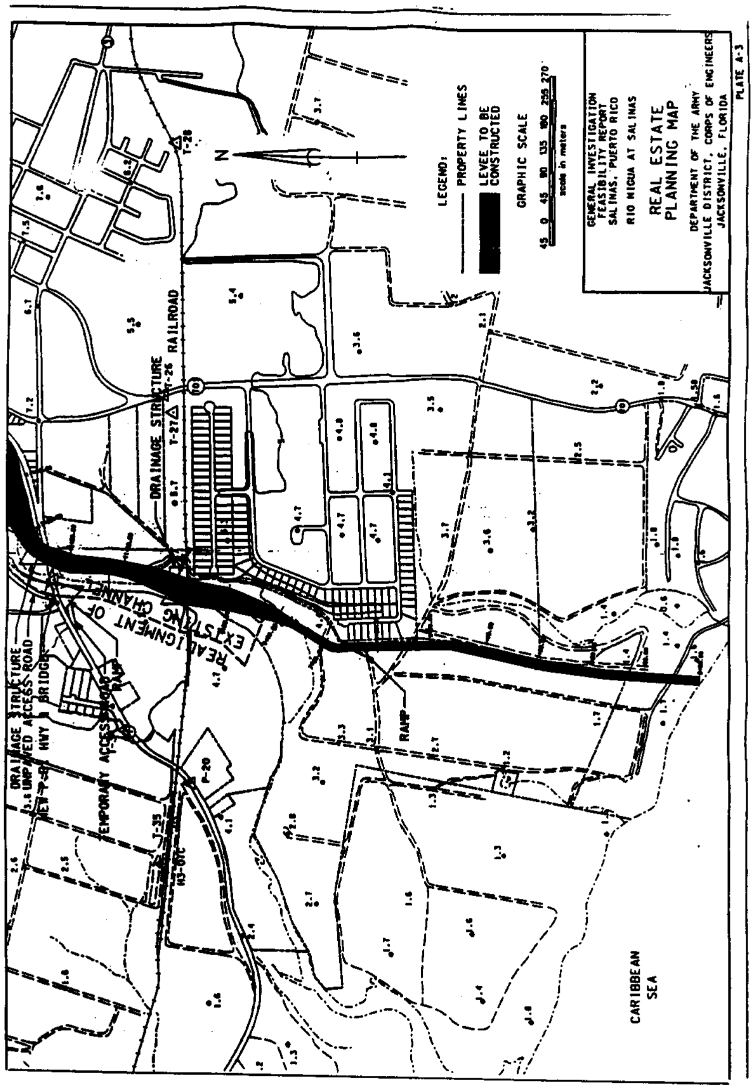
Rio Nigua at Salinas-Coco Levee

01	LANDS AND DAMAGES	
01A00	PROJECT PLANNING	$ 3,000
01B--	ACQUISITIONS	
01B20	BY LOCAL SPONSOR (LS)	5,000
01B40	REVIEW OF LS	2,000
01C--	CONDEMNATIONS	
01C20	BY LS	0
01C40	REVIEW OF LS	0
01E--	APPRAISALS	
01E30	BY LS	3,000
01E50	REVIEW OF LS	1,500
01F--	PL 91-646 ASSISTANCE	
01F20	BY LS	0
01F40	REVIEW OF LS	0
01G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY	
01G20	BY LS	1,000
01G40	REVIEW OF LS	500
01G60	DAMAGE CLAIMS	1,000
01M00	PROJECT RELATED ADMINISTRATION	
	REAL ESTATE REVIEW OF PCA	

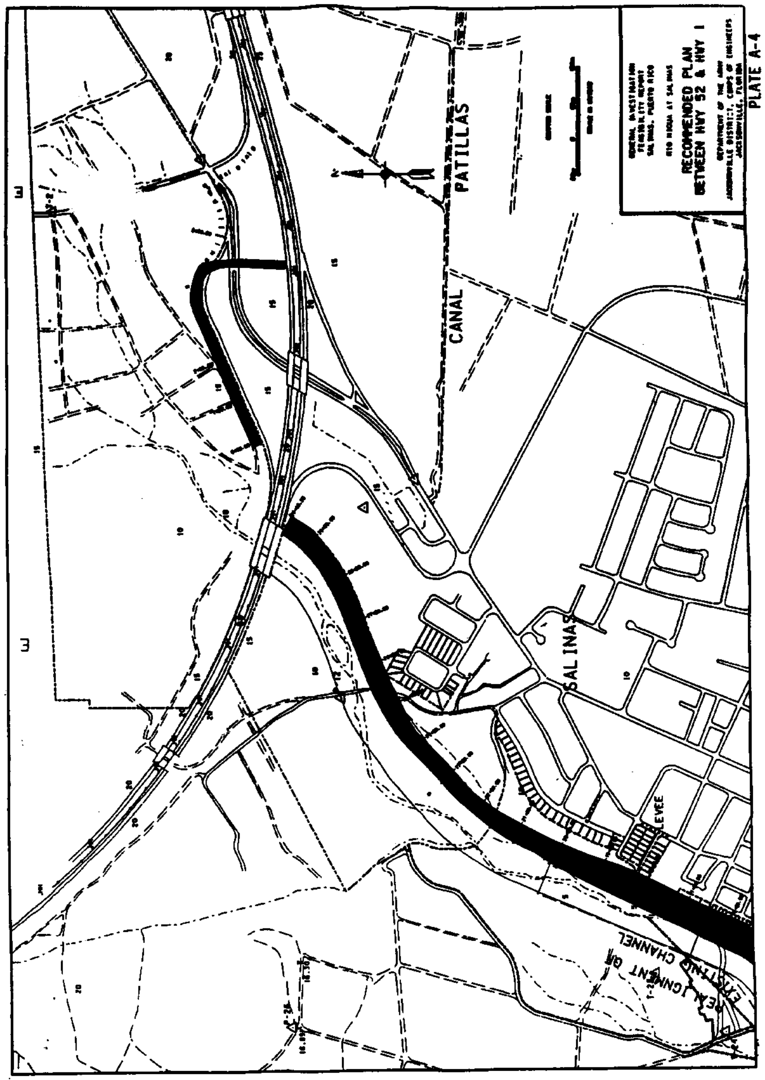
01R--	REAL ESTATE PAYMENTS		
01R10	LAND PAYMENTS		
01R1B	BY LS		67,960
01R2	PL 91-646 ASSISTANCE PAYMENTS		
01R2B	BY LS		0
TOTAL REAL ESTATE COST EXCLUDING CONTINGENCY			$ 84,960
TOTAL REAL ESTATE CONTINGENCY COST		$ 21,240	
TOTAL PROJECT REAL ESTATE COST (RD)			$ 106,000

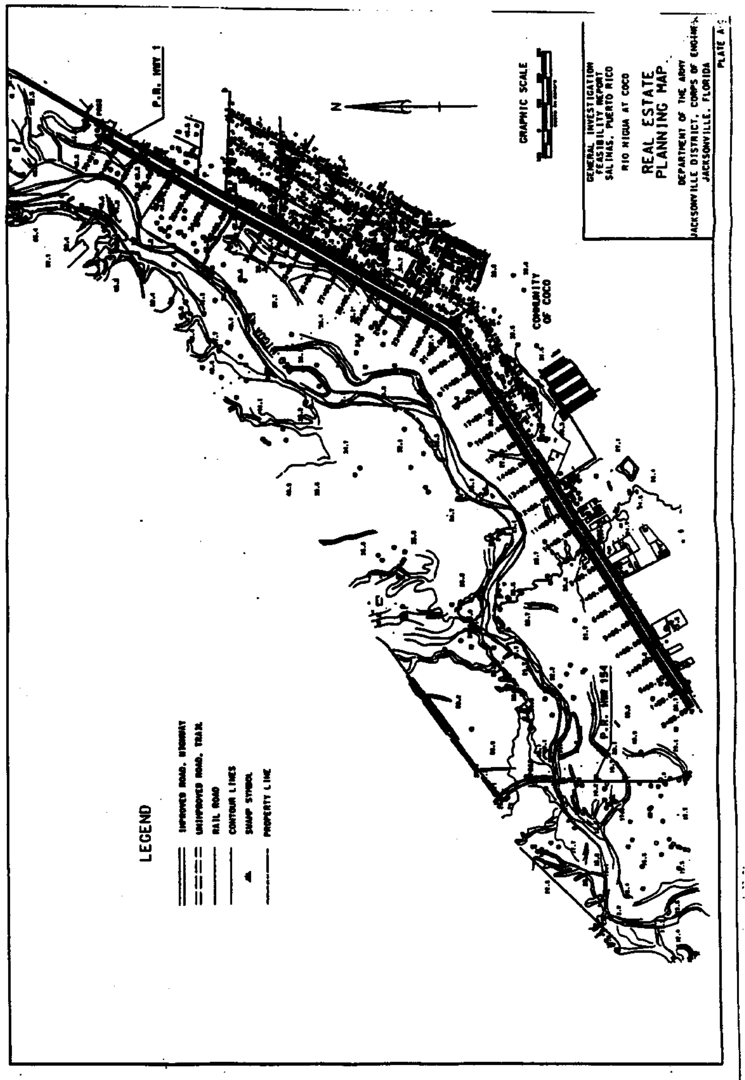
Rio Nigua at Salinas-Borrow/Disposal Areas

01	LANDS AND DAMAGES	
01A00	PROJECT PLANNING	$ 2,000
01B--	ACQUISITIONS	
01B20	BY LOCAL SPONSOR (LS)	10,000
01B40	REVIEW OF LS	4,000
01C--	CONDEMNATIONS	
01C20	BY LS	0
01C40	REVIEW OF LS	0
01E--	APPRAISALS	
01E30	BY LS	3,000
01E50	REVIEW OF LS	1,500
01F--	PL 91-646 ASSISTANCE	
01F20	BY LS	0
01F40	REVIEW OF LS	0
01G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY	
01G20	BY LS	1,000
01G40	REVIEW OF LS	500
01G60	DAMAGE CLAIMS	1,000
01M00	PROJECT RELATED ADMINISTRATION	
	REAL ESTATE REVIEW OF PCA	0
01R--	REAL ESTATE PAYMENTS	
01R10	LAND PAYMENTS	
01R1B	BY LS	112,500
01R2	PL 91-646 ASSISTANCE PAYMENTS	
01R2B	BY LS	0
TOTAL REAL ESTATE COST EXCLUDING CONTINGENCY		$ 135,500
TOTAL REAL ESTATE CONTINGENCY COST		$ 33,900
TOTAL PROJECT REAL ESTATE COST		$169,400



LEGEND:
PROPERTY LINES
LEVEE TO BE CONSTRUCTED
GRAPHIC SCALE
GENERAL INVESTIGATION FEASIBILITY REPORT SALINAS, PUERTO RICO
RIO NIGUA AT SALINAS
REAL ESTATE PLANNING MAP
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PLATE A-3
RAILROAD
DRAINAGE STRUCTURE
RAMP
CARIBBEAN SEA


RECOMMENDED PLAN
BETWEEN HWY 52 & HWY 1
PLATE A-4
PATILLAS
CANAL
SALINAS
LEVEE
EXISTING CHANNEL
REALIGNMENT OF



GENERAL INVESTIGATION
FEASIBILITY REPORT
SALINAS, PUERTO RICO
RIO NIGUA AT COCO
REAL ESTATE
PLANNING MAP
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
GRAPHIC SCALE
N
P.R. HWY 1
COMMUNITY OF COCO
P.R. HWY 154
LEGEND

RIO NIGUA AT SALINAS

BORROW AREA LOCATION MAP

Exhibit A

RIO NIGUA AT SALINAS

DISPOSAL AREA LOCATION MAP

N

Exhibit B

RIO NIGUA AT SALINAS, PUERTO RICO
FEASIBILITY REPORT

APPENDIX F
ECONOMIC ANALYSIS

TABLE OF CONTENTS

RIO NIGUA AT SALINAS FEASIBILITY REPORT

APPENDIX F
ECONOMIC ANALYSIS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

RIO NIGUA AT SALINAS FEASIBILITY REPORT

APPENDIX F
ECONOMIC ANALYSIS

TABLE OF CONTENTS (Cont.)

LIST OF FIGURES

LIST OF PLATES

(Plates follow text.)

APPENDIX F
ECONOMIC APPENDIX

I. INTRODUCTION

A. General

This appendix presents the description of the detailed study area along Río Nigua at the Municipality of Salinas. It includes the socioeconomic characteristics, the analysis of estimated potential flood damage for existing (1995) without project condition, the with project condition, and the benefits to be derived with a project in place.

The appendix contains brief descriptions of field investigations completed to define the study conditions, to assess the flood damages, and develop flood control measures that would be necessary to alleviate the flooding problems. The annual flood damages were determined using a risk-based approach. This analysis utilized the @RISK software system in combination with a Lotus 1-2-3 template developed by the Institute of Water Resources. This computer simulation model was designed to determine the relationship between river stage and damage. It utilizes sampling of a large number of possible alternatives from a set of probability distributions that incorporate the most significant uncertainties in the evaluation.

B. Methodology, Assumptions, and Constraints

This part of the analysis presents the economic assumptions and methodology used in computing average annual equivalent flood damages for the study area.

1. Plans were evaluated separately for two areas: the urban area of Salinas including Salinas "Playa" and Coco community. Plans for each area were justified by themselves.

2. For purpose of optimization of net National Economic Development (NED) benefits, risk and uncertainty analyses was incorporated as part of the study effort.

3. Total beneficial contributions of each plan considered must exceed the total adverse impacts, and one of the plans must maximize net NED benefits.

4. Preliminary and final plans were developed reflecting 1995 price levels. The recommended plan reflects 1996 price levels.

5. Values of structures and contents for all types of facilities in the flood plain are estimated on the basis of field surveys, revision of appraisal records in the area, construction cost data from the Puerto Rico Permits and Regulations Administration, and comparable data from recent completed surveys. These values reflect 1995 price levels depreciated replacement cost. They do not include value of land or any premium caused by speculation in the market.

6. Damage curves used were developed using historical data on flood damages throughout the island.

7. The "Depth versus Percent Damage" relationships used in this report for residential properties are based on historical data from post flood damages. The curves were compiled in 1984 and are still considered valid.

8. The damage curves for commercial and public structures and their contents are based on historical damages and claims developed by a professional for the Río Puerto Nuevo area. Both of these sets of curves reflect typical building and content losses.

9. Risk and Uncertainty analysis on hydrology, hydraulics, and economic variables was undertaken to determine annual flood damages. The analysis does not include uncertainty associated with costs estimates. The risk and uncertainty in Salinas was performed using the @RISK software system in conjunction with a Lotus 1-2-3 template.

10. The Latin Hypercube technique of sampling is used as the default sampling type for the model since it converges faster on the true statistic of the input distribution.

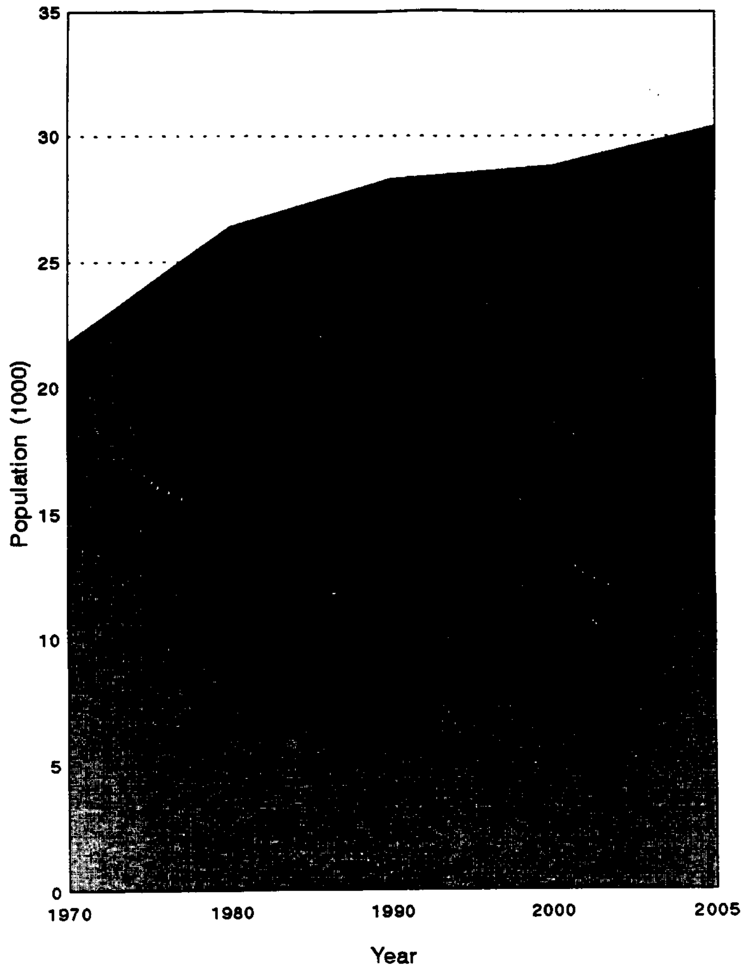
C. Socioeconomic Profile

The Municipality of Salinas is located in the southern part of Puerto Rico, 33 kilometers east from the city of Ponce, the second largest in the island. Salinas is territorially subdivided in six "barrios" similar to wards: the Aguirre, Lapa, Palmas, Quebrada Yeguas, Río Jueyes, and Barrio-Pueblo or urban area. This urban area interconnects the central business district and older housing sectors downtown with the new housing developments and the Playa sector or coastal-area. Due to its location along the river, the business district, major public facilities, and old residential developments experience serious flooding problems. As a consequence of river flooding, city expansion has occurred towards the elevated ground of the northeastern sector along PR Highway 3 and Highway 52.

1. Population. According to the 1990 US Census of Population and Housing, the total population for Salinas was 28,335, a 7 percent increase from 1980. The population is expected to grow to 30,374 in the year 2005 (see Figure F-1). Urban population represents 47 percent of the municipality's total population, while the rural area contains 53 percent. Median age was 26 years. The Playa sector is influenced by a "floating" tourist population during weekends attracted by amenities at the beaches and the boating facilities. This activity is mostly generated to the southern and western part of the Municipality of Salinas.

2. Employment. According to the June 1995 Labor Market Information Newsletter, the civilian labor force in the Municipalities of Salinas, Guayama, Patillas labor area was 29,500 persons. Most of the employment is centered in the public administration sector with 38.7 percent, followed by agriculture with 21.7 percent of the total. Manufacturing accounts for 16.5 percent of the jobs in this area. Trade and services account for 12.6 and 7.0 percent of the labor force, respectively. The nonmanufacturing sector accounts for 48 percent or 14,200 workers. The unemployment rate is 21.9 percent. This is much higher than the island's rate, which is 12.8 percent for the same period of analysis (see Table F-1 and Figure F-2).

POPULATION IN MUNICIPALITY OF SALINAS
1970 TO 1990 AND PROJECTION FOR 2005

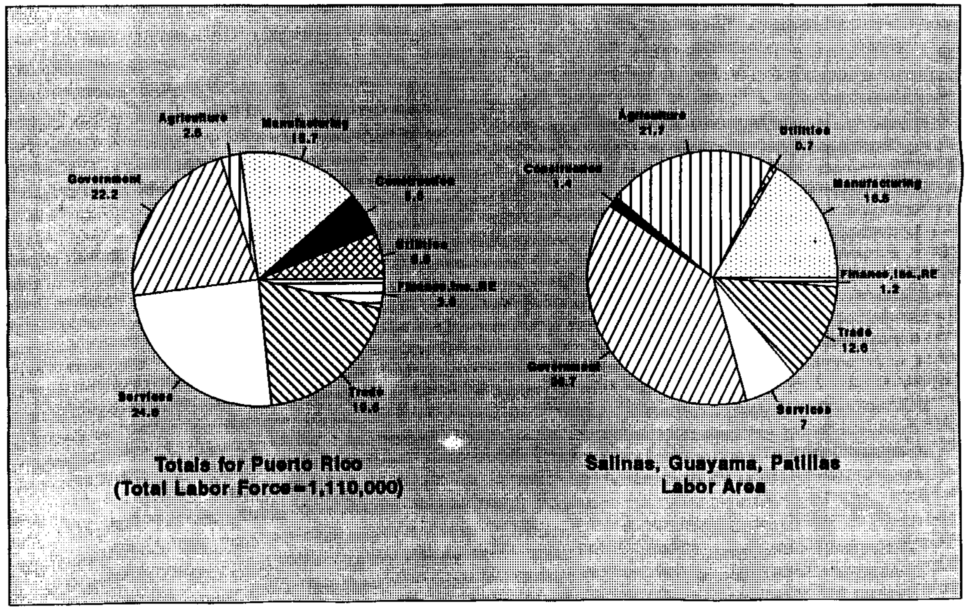


Projection provided by the P.R. Planning Board, Bureau of Census

Figure F-1

EMPLOYMENT BY SECTOR

Percentages as of November 1995



Source: P.R. Department of Labor and Human Resources
Figure F-2

TABLE F-1

DISTRIBUTION OF EMPLOYED PEOPLE BY MAJOR ECONOMIC SECTOR
AS OF JUNE 1995
(Salinas, Guayama, and Patillas Labor Area)

Total Labor Force		29,500
Employed	23,000	
Unemployed	6,500	
Unemployed Rate	21.9%	
Distribution:		
Manufacturing		3,800
Nonmanufacturing		14,200
Construction	320	
Transportation, Communications, etc.	150	
Trade	2,900	
Finance	280	
Services	1,620	
Government	8,900	
Agriculture and Related		5,000

3. Infrastructure. The transportation network between Salinas and the Metropolitan Area of Ponce and San Juan is one of the most important facilities of the area. Expressway PR-53 connects this town directly with San Juan and Ponce.

Also, one of the largest power-generating facilities of the Puerto Rico Electric Power Authority is located in the Municipality of Salinas. This plant produces approximately 35 percent of the total electric power capacity of Puerto Rico (estimated in $2,600 MW). In addition, the town of Salinas is connected directly to the Guayama Regional Waste Water Treatment Plant with a capacity of 10 MGD.

II. EXISTING CONDITIONS

A. General Flood Plain Characteristics

The flood plain of Río Nigua at Salinas comprises 625 acres of developed urban land, 32 acres of undeveloped urban land, 248 acres of prime agricultural land, and approximately 50 kilometers of streets and highways. A total of 3,022 residential units and an industrial park comprising 16 buildings are also affected by flooding. The flood plain is a predominantly flat area with a gradual elevated slope to the northwest away from the river. Approximately 90 percent of the city or "pueblo" of Salinas lies within the flood plain. Most of the major commercial, industrial, and public activity of the town is disrupted during flood events.

B. Detailed Study Area and Reaches

The detailed study area is divided into two damage reaches for purpose of economic analysis, plan formulation, and evaluation. See Plate 1 at the end of this Economic Appendix for delineation of reaches. The total area encompasses approximately 3,400 structures of all land uses, major transportation routes, parks, and health services centers.

Reach 1, the downstream portion, extends from the coastline and ends just south of PR Highway 52. This reach includes the coastal community known as "Playa-Salinas," the downtown residential zone of the city, and the business and industrial sector. The upstream portion, Reach 2, extends along PR Highway 1 and includes Coco community. Refer to Table F-2 and Plate F-1 for further details.

TABLE F-2

REACHES AND NODES FOR ECONOMIC ANALYSIS

REACH	NODES	DESCRIPTION OF SECTORS
1	1-2-3-5	Coastal area, core of town; residential, commercial, public, nonprofit, utilities, streets and highways; land uses included in each sector.
	4	Industrial area in southern part of town
2	1-6	Coco community: land uses include residential, commercial, public, nonprofit, utilities, and streets.

C. Inventory of Property Subject to Flooding

In this report, property subject to flooding is organized into land use categories which prevail along Río Nigua at Salinas. Further on, this property was aggregated into major groups for risk analysis.

1. <u>Residential</u>. In Reach 1, approximately 2,342 residential structures are flooded by the 100-year flood. These are distributed in different types of residential developments: single-family housing detached with about 1,191 units of reinforced concrete structures, 98 units of row housing apartments, and approximately 311 units of single-family housing scattered in the inner town area. These structures are built mostly of concrete and some of mixed concrete, wood, and frame materials. In the coastal area, "Playa Sector," there are about 742 structures of reinforced concrete and mixed concrete and wood. Most of the residential developments are homogeneous with the same design utilized for

building each house. Most structures have 3 bedrooms and one bathroom with living, dining room, kitchen, and carport for 1 car. In the downtown area residential structures are smaller in size with minor variations in construction size and materials. Size of the lot varies from 280 to 450 square meter. About 75 percent of the families affected belong to low-to-middle income groups. In Reach 2, at Coco community, there are approximately 680 structures flooded by the 100-year flood.

Coco community was initially developed by the government as a rural community with lots ranging in size from 900 square meters to 2,000 square meters provided free of charge. This land distribution was done with the purpose of agricultural subsistence of the families residing in the original 3 bedrooms/1 bath structures with an average size of 600 square feet. This initial housing development has evolved and 2 to 3 housing structures can be found in the same lot with relatives living in detached units. Most of the structures (over 95 percent) are of reinforced concrete. Table F-3 illustrates the total number of residential structures affected by the 100-year flood and their associated structure and content value.

TABLE F-3

PROPERTY SUBJECT TO FLOODING
RESIDENTIAL LAND USE

REACH	SECTOR	NUMBER OF STRUCTURES	AVERAGE STRUCTURE VALUE	AVERAGE CONTENT VALUE
1	Coastal Area	742	24,500	7,800
	Town South	327	36,200	9,500
	Town Core	44	28,700	7,700
	Town Periphery	128	32,000	8,700
	TOTAL REACH 1	2,342	29,300	8,200
2	Coco Ward (upstream)	680	23,500	7,800
1&2	TOTAL DETAILED STUDY AREA	3,022	28,000	7,800

2. Commercial. Approximately 259 commercial structures are flooded in the detailed study area; 225 are located in Reach 1 and 34 in Reach 2. These businesses were arranged into categories according to the type of activity, the merchandise, equipment, and services offered. Similarities in the display of content is another criteria used to categorize the stores. For content value, field data was obtained from flood plain occupants through interviews performed during 1994 and 1995. The description of the various commercial categories follows:

a. Category 1. Professional services offices, general merchandise outlets, miscellaneous retail stores, auto parts stores, sporting goods stores, drugstores, electrical equipment stores, food stores, auto services outlets, and apparel and accessories stores. There are a total of 117 retail stores in Reach 1 and 17 in Reach 2.

b. Category 2. Personal and business service outlets. Thirty-five of these outlets are located in Reach 1 and only 1 in Reach 2.

c. Category 3. Eating and drinking places, repair services shops, and small building materials distributors. There are a total of 62 of these outlets in Reach 1 and 15 in Reach 2.

d. Category 4. Auto dealer business. There are four of these businesses operating in the urban core (Reach 1) and 1 in Coco community (Reach 2).

e. Category 6. Finance institutions and real estate offices. Four of them are located in the downtown of Salinas (Reach 1) and one in Coco community.

f. Category 7. Warehouses. These are large commercial establishments oriented toward serving the whole municipal population and smaller retail outlets. One of these outlets is located in downtown Salinas.

Table F-4 shows the distribution of commercial establishments affected by floods in each reach by major commercial category and frequency of flooding.

TABLE F-4

PROPERTY SUBJECT TO FLOODING
COMMERCIAL STRUCTURES

	Exceedance Frequency (Years)				
Type of Business	10	25	50	100	SPF
REACH 1					
Category 1	25	40	43	117	117
Category 2	9	12	17	28	36
Category 3	12	13	13	62	62
Category 4			4	4	5
Category 6				4	4
Category 7			1	1	1
Total Reach 1	46	65	82	216	225
REACH 2					
Category 1	16	16	16	17	17
Category 2	1	1	1	1	3
Category 3	14	14	14	15	15
Category 4	1	1	1	1	1
Total Reach 2	32	32	32	34	34
TOTAL DETAILED STUDY AREA	78	97	114	250	259

3. Public. The public category comprises all facilities operated by the Commonwealth and municipal governments. In the Reach 1 it includes schools, a public health center, a Police Department Headquarters, a professional baseball stadium, government offices center, U.S. Post Office, Salinas Museum, Civil Defense Offices, town square, City Hall offices, and other facilities typical of the urban core. In Reach 2, the Coco community, the facilities included are schools.

4. Nonprofit organizations. This category groups private schools, churches, a center for the elderly, and a political party office. Table F-5 shows total public and nonprofit facilities affected by flooding.

TABLE F-5
PROPERTY SUBJECT TO FLOODING
PUBLIC AND NONPROFIT STRUCTURES AND FACILITIES

LAND USE	EXCEEDANCE FREQUENCY (YEARS) 10	25	50	100	SPF
REACH 1					
Elementary Schools	23	19	23	23	23
Head Start Facility	4	6	6	6	6
Public Administration Facilities	19	42	50	50	2
Public Works Offices	2	2	2	2	1
Public Cemetery Facilities		1	1	1	1
Intermediate High Schools		13	20	20	20
Church			13	13	2
Other Nonprofit Facilities			2	2	2
TOTAL REACH 1	38	83	117	117	117
REACH 2					
Elementary Schools	7	7	7	7	3
Church		3	3	3	10
TOTAL REACH 2	7	10	10	10	10
TOTAL PUBLIC AND NONPROFIT FACILITIES	45	93	127	127	127

5. Utilities. Included in this category for the urban sector and Playa area are: an electrical substation, utility structures of the Puerto Rico Electric Power Authority (PREPA), and a telephone central station of the Puerto Rico Telephone Company (PRTC).

This category also includes the water, telephones, sewage, and electric power lines and meters within the study area. No detailed data is available on the specific number of such facilities; therefore, they are measured on the basis of acreage of land developed.

6. Industrial. An industrial park which consists of 16 structures subject to flooding are located in the southern part of the urban sector. Some of the principal concerns located at this park, by occupancy, are indicated below:

Industry	Total Area (Sq. Feet)
Westinghouse, ABB, PR Inc.	44,843
ALTAMADELTA PR	22,656
COTTET Optical Corp.	26,275
Steri-Tech, Inc.	22,672
Plasticon, Inc.	22,553
Universal Plastics	11,240

7. Highways and streets. This category includes all sidewalks, roads, highways, and streets in the flood plain area. Kilometers of affected streets and highways by flooding were measured from flooded area maps developed for this study. Approximately 22.9 kilometers are affected by the 100-year event in Reach 1 area and 12.3 kilometers in Reach 2. Refer to Table F-6.

TABLE F-6

PROPERTY SUBJECT TO FLOODING
KILOMETERS OF STREETS AND HIGHWAYS

TYPE OF ROAD	EXCEEDANCE FREQUENCY (YEARS)					
	5	10	25	50	100	SPF
REACH 1						
Streets	0	1.4	6.8	15.0	21.2	22.0
Highways	0	0	1.1	1.7	1.7	1.9
Total Reach 1	0	1.4	9.9	17.2	22.9	23.9
REACH 2						
Streets	7.7	8.6	9.6	9.6	9.6	9.6
Highways	2.2	2.7	2.7	2.7	2.7	2.7
Total Reach 2	9.9	11.3	12.3	12.3	12.3	12.3
TOTAL STUDY AREA	9.9	12.7	22.2	29.5	35.2	36.2

8. Agriculture. Río Nigua at Salinas floods a large agricultural area East and West of its banks. Until recently the entire valley was a sugar cane plantation. Presently, some of the land is used to grow a variety of vegetables. The Department of Agriculture and private owners have plans to continue use of this prime agricultural land. East of the river bank and south of the urban area of town there are 248 acres that will be protected by the proposed project.

B. Assessment of Property Values

Values of structures and contents for all types of facilities within the flood plain are estimated on the basis of field visits, revision of appraisals records in the area, construction cost data from the Puerto Rico Permits and Regulations Administration, and comparable data from recent completed survey reports such as the Río de la Plata Limited Reevaluation Report (Jacksonville District 1992) and the Río Grande de Arecibo Survey Report (Jacksonville District, 1993). Values reflect 1995 price level replacement costs and do not include land values.

a. Residential. Residential content values were determined through field investigations. A statistically determined random sample was obtained from each of the residential developments of the study area. Average and standard deviation of the content values obtained were estimated for each sector. The values represent depreciated replacement costs at 1995 price levels. Homogeneity of design of structures and income group families in these sectors allowed for the use of average figures to estimate total structure and content values.

b. Other land uses. Content values for commercial, public, nonprofit, and utilities were obtained through a field investigation conducted on 100 percent of the establishments within the study area. The values for machinery, equipment, and accessories represent depreciated cost of replacement at 1995 price levels.

c. Other property (external to main structure). This property refers to lawns, yards, parking areas, fences, automobiles, and other facilities outside the main structures. Values for this property were obtained through field visits and were integrated with the various land uses.

III. DEPTH-DAMAGE RELATIONSHIPS

Depth-damage relationships for the residential, commercial, and public land uses developed for the Río Puerto Nuevo Survey Report (Jacksonville District, 1984) and the Río Cibuco Detailed Project Report (Jacksonville District 1982) were utilized to estimate flood damages for existing development. Damage curves were developed using historical data on flood damages throughout the island.

Depth-damage curves on a percentage basis were developed for the residential and commercial land uses and for public schools. Available historical damage data for comparable areas throughout the island allowed the establishment of relationships between depth of water and percentage damage potential to structure and contents for residential, commercial, and school facilities. Such data were not available for some land uses and the depth-damage relationships were established on an absolute basis from information provided by representatives of those land uses.

1. Residential. To determine the damage susceptibility of residential structures, the actual damages to 250 comparable structures throughout Puerto Rico during the floods of Eloise (1975) were analyzed. The data was obtained from the Damage Survey Reports (DSR) of the Federal Disaster Assistance Administration known today as the Federal Emergency Management Agency (FEMA). Damages were repaired under the Minimum Repair Program of that agency. For each residential structure, the cost of replacing or repairing the structural damages was divided by the total estimated value of the structure. A minimum-least-squares curve of the percentages of structural damages related to the depth of water was fitted to the data. The curve was used to determine structural damages to all residential structures within the flood plain. Most of the structural damages are to the following categories: electric system, plumbing system, windows, doors, air conditioning units, water heaters, kitchen cabinets, built-in stoves and ovens, bathroom fixtures, wall-to-wall carpeting, paint, and other furnishings. The foundations and the structures do not suffer significant damages because they are built of reinforced concrete. These are affected mostly in areas near the river banks where velocities are significant. Due to lack of data, relationships between velocities and damage potential could not be developed and were not considered. To determine residential contents damage susceptibility, actual damages to contents in 30 residential structures in the Puerto Nuevo area during the 1977 flood were analyzed. These data were obtained

from the Small Business Administration records on disaster loans to residents in the area and from records of flood insurance policy claims from the National Flood Insurance Program (NFIP). The value of contents damaged was divided by estimates of the total value of contents, and a minimum-least-square regression of percentage of contents damages to depths of water was fitted to the data. This curve was then used to determine damages from different flood stages to the contents of residences throughout the flood plain. The historical depth of water was obtained from the U.S. Geological Survey records and from residents of the area. The curves were updated in 1987 using actual flood damages to 98 housing structures from the 1985 floods along the Río Cibuco. On the basis of field surveys, average structures' first floor elevation is generally taken to be about 0.15 to 0.30 meter for residential areas. Refer to Figure F-3.

2. Commercial establishments. Curves derived for the various categories of commercial establishments for the Río Puerto Nuevo area were developed by a professional appraiser with considerable experience in investigating claims under the National Flood Insurance Program (NFIP).

Average damages in terms of a percentage were determined by the analysis of claims under the NFIP. Empirical data were used to develop damages for floodwaters of a depth less than 1.2 meters. Percentage figures for damages occurring at depths over 1.2 meters were estimated by the appraiser on the basis of professional judgment. Although similar in nature, different types of businesses show different contents damage percentages since the merchandise is displayed differently. For commercial facilities, major structural damages consist of the electrical system, plumbing facilities, doors, windows, air conditioning units, and other furnishings. These relationships are indicated on Figures F-4, F-5, F-6, F-7, F-8, and F-9.

In some instances a total loss at depths of 1.2, 2.1, or 2.4 meters has been considered. In other cases total loss does not occur at this depth. The average floor-to-ceiling height in an average commercial building is between 2.4 and 3.1 meters, while other types of businesses have higher ceilings and some property is stored or placed above 2.4 meters.

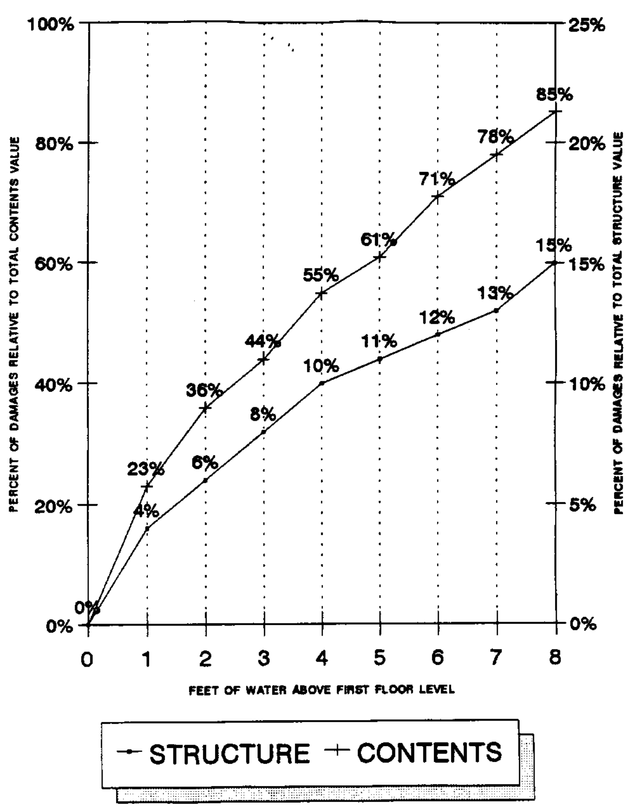
3. Public buildings and offices. Damage estimates to structure and contents of public buildings and offices were ascertained using the depth-damage relationship developed for elementary schools. For school buildings, data provided by the Superintendent of Schools, the school directors, the Public Buildings Authority, and the Puerto Rico General Services Administration were used to develop basic depth-damage relationships. Refer to Figures F-10 and F-11.

4. Nonprofit organizations. Damage potential to the structures and contents of these facilities are shown in Figure F-12.

5. Utilities. Cleanup and repair costs for water; sewage; electric, gas, and telephone lines; meters; and power stations were estimated at $2,000 per 4,000 square meters of developed land in the flood plain. These figures are based on field observations and discussions with representatives from the various utilities companies.

6. Highways and streets. Damage to highways and streets were estimated applying a percentage of the cost of repair per kilometer to the number of kilometers flooded for each flood frequency analyzed. Damage per kilometer was

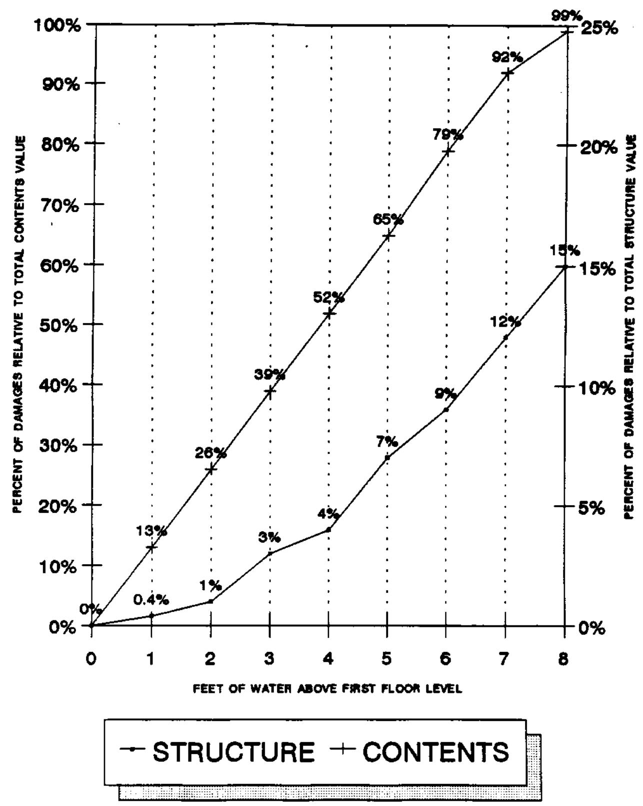
DEPTH DAMAGE RELATIONSHIP
FOR RESIDENTIAL LAND USE



US ARMY CORPS OF ENGINEERS

FIGURE F-3

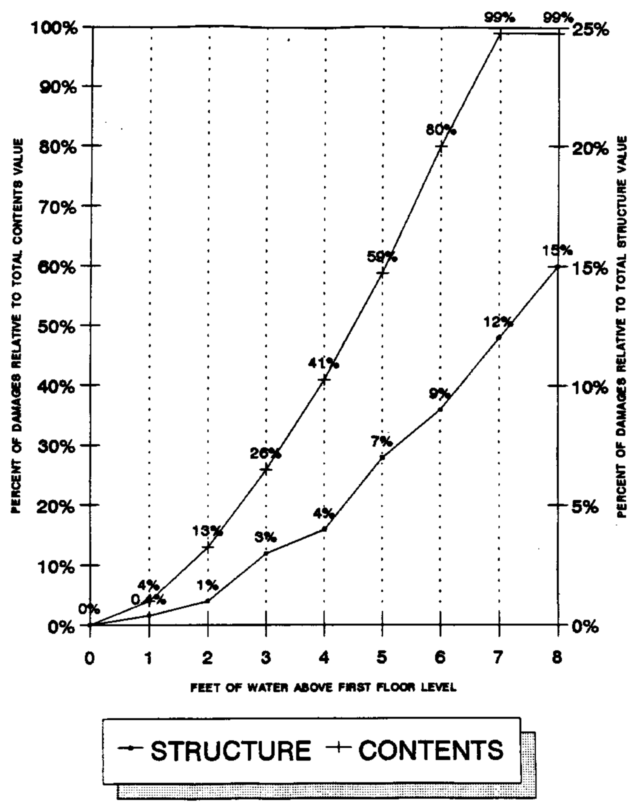
DEPTH DAMAGE RELATIONSHIPS
COMMERCIAL CATEGORY 1



US ARMY CORPS OF ENGINEERS

FIGURE F-4

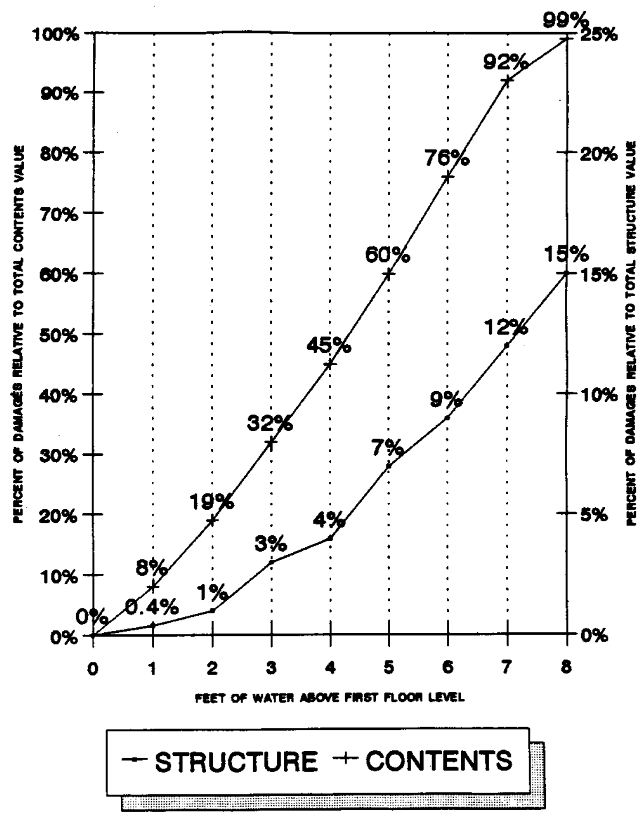
DEPTH DAMAGE RELATIONSHIPS
COMMERCIAL CATEGORY 2



US ARMY CORPS OF ENGINEERS

FIGURE F-5

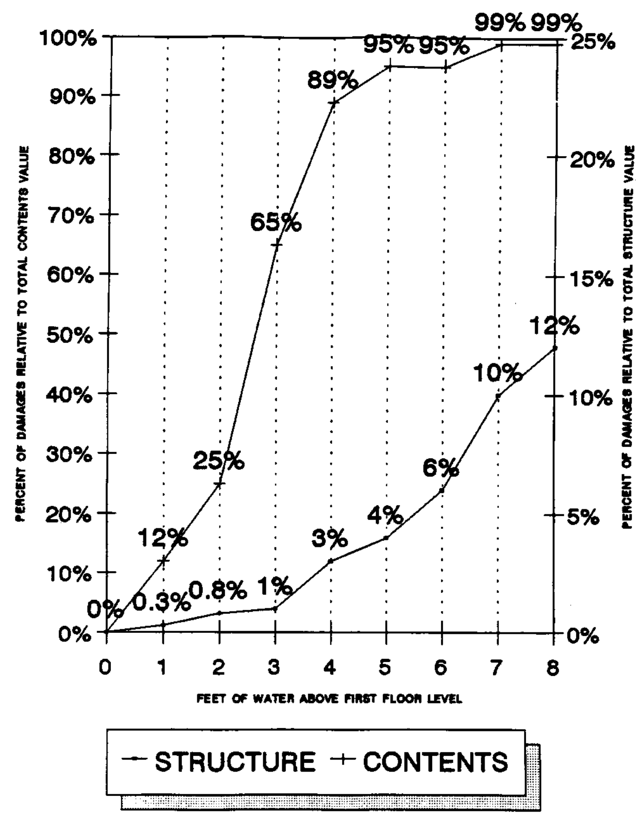
DEPTH DAMAGE RELATIONSHIP
COMMERCIAL CATEGORY 3



US ARMY CORPS OF ENGINEERS

FIGURE F-6

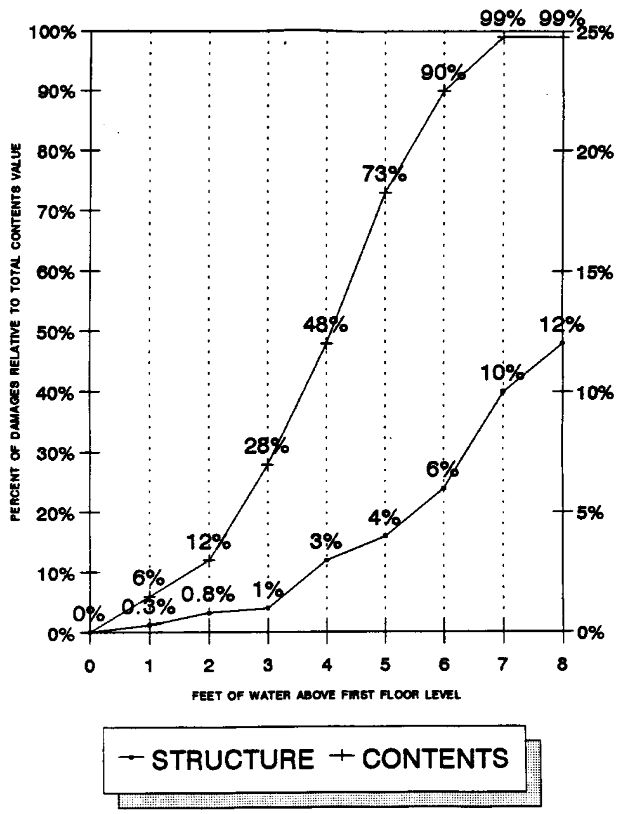
DEPTH DAMAGE RELATIONSHIP
COMMERCIAL CATEGORY 4



US ARMY CORPS OF ENGINEERS

FIGURE F-7

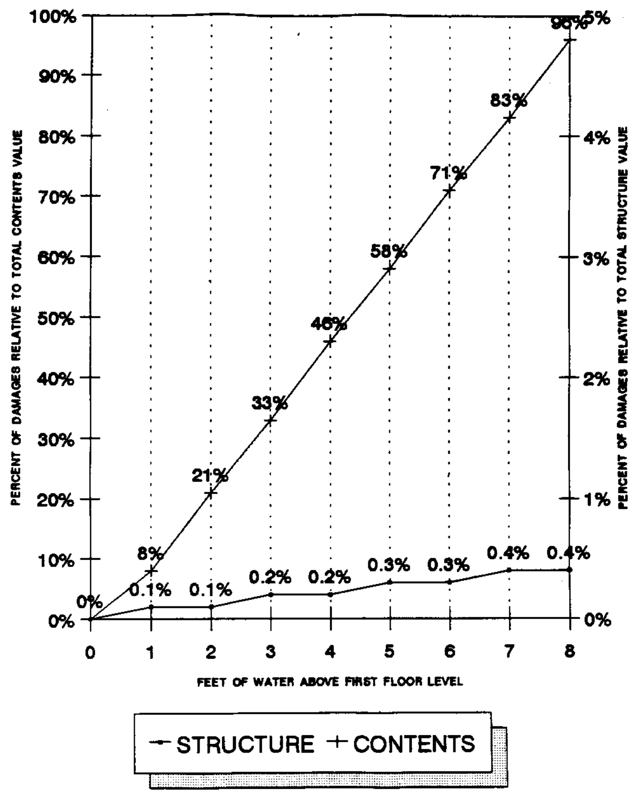
DEPTH DAMAGE RELATIONSHIP
COMMERCIAL CATEGORY 6



US ARMY CORPS OF ENGINEERS

FIGURE F-8

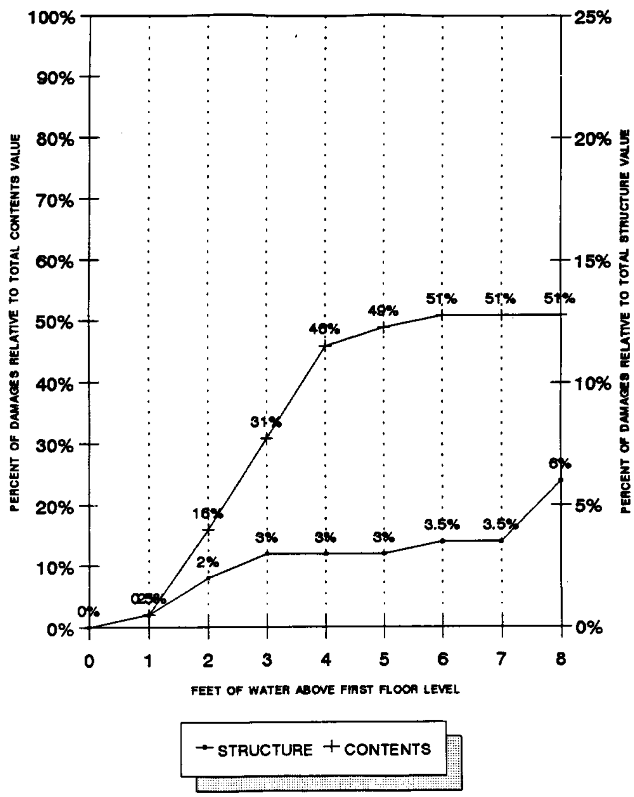
DEPTH DAMAGE RELATIONSHIP
COMMERCIAL CATEGORY 7



US ARMY CORPS OF ENGINEERS

FIGURE F-9

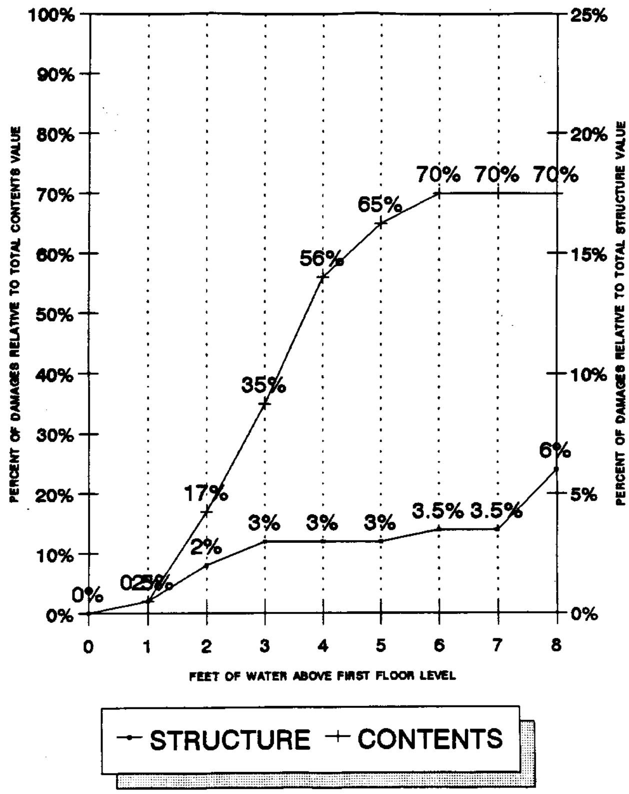
DEPTH DAMAGE RELATIONSHIP
PUBLIC CATEGORY 9 (ELEMENTARY SCHOOLS)



US ARMY CORPS OF ENGINEERS

FIGURE F-10

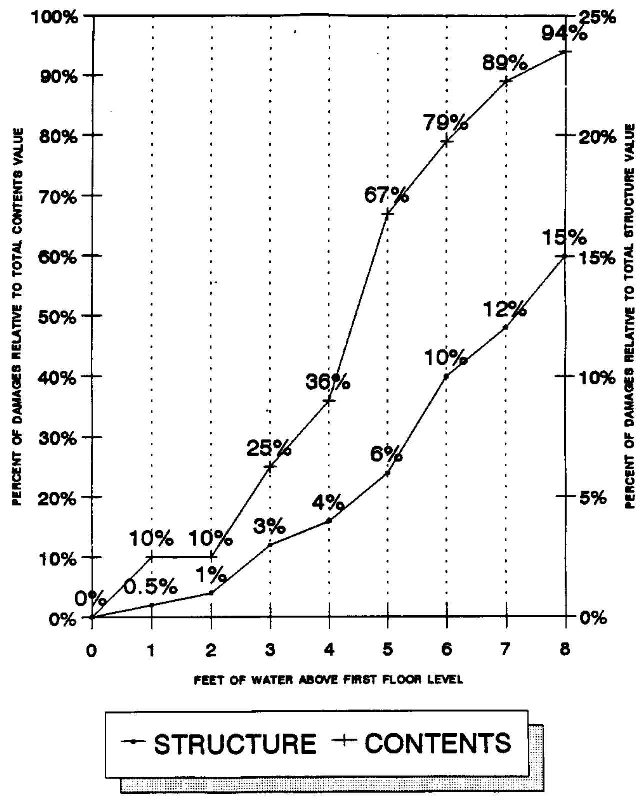
DEPTH DAMAGE RELATIONSHIP
PUBLIC CATEGORY 10 (SECONDARY SCHOOLS)



U. S. ARMY CORPS OF ENGINEERS

FIGURE F-11

DEPTH DAMAGE RELATIONSHIP
NON-PROFIT LAND USE



US ARMY CORPS OF ENGINEERS

FIGURE F-12

developed through discussions with officials of the San Juan Regional Office of the Department of Transportation and Public Works (DTPW). Analysis of current highway construction and repair costs were obtained from a variety of sources. In accordance with the DTPW, the total cost of repairing a badly damaged two-lane highway is $79,600 per kilometer. Damages to highways during the SPF, 100-, 50-, 25-, and 10-year flood events were estimated at $64,000, $48,000, $32,000, $16,000, and $8,000 per kilometer, respectively. Damages to streets were estimated at 50 percent of the highway damage per kilometer.

IV. RISK-BASED ANALYSIS

A. Overview

1. Introduction. The Río Nigua at Salinas existing conditions, the flood plain inventory by reach and land use, the valuations for the structures listed and described with their average assessed values are the basis for the analysis of risk and uncertainty. The framework regarding uncertainty on economic, hydrology and hydraulic estimates was undertaken following guidance of EC-1105-2-205 of June 30, 1992. Risk and uncertainty underlying hydrology and hydraulic estimates are discussed in Appendix A (Hydrology and Hydraulics) and in the main report. The analysis does not include uncertainty associated with costs estimates. The @Risk analysis and simulation add-in for Lotus 1-2-3 was used in this analysis along with a stage-damage worksheet designed by the Institute of Water Resources (IWR) adapted to the conditions of the study area.

EC-1105-2-205 defines the risk-based analysis framework as an approach to evaluation and decision making that explicitly and to the extent practical, analytically incorporates considerations of risk and uncertainty. In this framework it is recognized that the true values of key planning and design variables and parameters are frequently not known with certainty and can take a range of values. One can describe, however, the likelihood of a parameter taking a particular value by a probability distribution. The probability distribution may be described by its own parameters, such as mean and variance for a normal distribution. In an analytical manner, the risk-based framework is an approach to combining the underlying risk and uncertainty information expressed in terms of probability distributions.

2. Risk-based plan formulation problem. The methodology related to risk and uncertainty involves the technical task of balancing the risk of exceeding the design height of the levee with flood damage prevented, uncertainty of flood levels with design accommodations, and providing with safe, predictable project performances. The analytical process involves the basic task to formulate and evaluate flood damage reduction project alternatives that provide protection that is appropriate and acceptable.

In the case of the economic estimates, the stage-damage relationship is shown as a probability function which incorporates possible statistical error in damage for a given stage. This uncertainty is represented by a probability distribution of damage error about stage-damage curves. Other variables in which uncertainty in data exists were considered in the generation of stage-damage curves for the Río Nigua at Salinas. These areas are: 1) structure values, 2) content values, 3) structure's first floor elevations, and 4) depth-percent damage curves. These are further discussed below in this appendix.

3. Stage damage curve. The stage damage curve utilized for each land use is a summary statement of the direct cost of flood water inundation for a specified reach. The various sources of risk and uncertainty in the individual stage damage curves are combined to determine the overall risk and uncertainty associated with the composite stage damage curve.

4. Simulation methodology. As was described above, this analysis on Risk and Uncertainty in the Río Nigua at Salinas study area was performed using the @RISK software in conjunction with a Lotus 1-2-3 template. The spreadsheet for each reach is comprised of structure values, first floor elevations, depth-percent damage curves, a range of elevations used in simulating stage-damages (simulation table) and the maximum and minimum truncation limits for each risk variable. This computer simulation model determines the relationship between river stage and damage by sampling a number of possible alternative conditions from a set of probability distributions which incorporate the most significant uncertainties in the evaluation. In the case of the Río Nigua at Salinas study area, two economics R&U matrices were used for Reach 1 (the urban area) and one for Coco community as follows:

R&U Matrix	Description
Reach 1 - Playa/Salinas	1. Residential , Commercial, and Autos 2. Industrial, Public, and Nonprofit
Reach 2 - Coco Community	All land uses included: residential, commercial, public, and nonprofit; and autos

Structure values are assumed to have a normal distribution with a mean value equal to the structure's depreciated replacement value. The distribution of structure values is confined to an error of plus/minus 3 standard deviations.

The content value with uncertainty was determined by surveying a sample drawn from each reach and node in the detailed study area. The uncertainty associated with structure and content values were combined with the appropriate depth/damage relationship to determine structure, content, and total damages for each flood elevation analyzed.

B. Risk Variables

Uncertainty was also quantified for error in the underlying components of the stage damage curve: structure values, contents value, first floor elevations and depth-percent damage. Structure values and content values for all types of facilities within the flood plain were estimated as described in section 1.b. of this appendix. Values reflect 1995 price level depreciated replacement costs and do not include land values.

1. Sample size for residential land use. A proportional random sample of the residential property subject to flooding in the Salinas flood plain was drawn from the population of each of the nodes in both reaches. Since some of the nodes produce a larger portion of the total damages than others, it was considered appropriate to include this fact in the computation of the sample size. The sample size for each node was selected proportional to 50 percent of its share to the total damages that were developed during the Reconnaissance stage of this study. Table F-7 indicates the results of the procedure.

TABLE F-7 PROPERTY SUBJECT TO FLOODING RESIDENTIAL SAMPLE		
REACH	**SECTOR**	**Sample Size**
1	Coastal Area	12
	Town South	13
	Town Core	12
	Town Periphery	13
	TOTAL REACH 1	50
2	Coco Community	11
1&2	**TOTAL DETAILED STUDY AREA**	61

To verify that the sample size selected was adequate, the formula for size of sample with 95 percent probability was applied utilizing the standard deviation for structure values obtained from data of the reconnaissance investigation. The information is still valid since physical development at Salinas is constrained due to the flooding problem. At that time the total flood prone area was surveyed for land uses and structure sizes. The survey (total population) provided a source of information concerning average structure sizes and average structure values. Based on this survey, areas with common characteristics (structure sizes, building materials, topography, etc.) were identified and grouped into nodes. It is common practice in Puerto Rico for developers to build a large number of residential units based on two, or at most three, structural models. In Salinas, for example, at Las Margaritas residential development, there are 327 housing units with two basic designs in terms of size. Similar conditions follow for "La Arboleda" with 224 units, "La Monserrate" with 162, and "Las Marías" residential development with 128 units for a total of 841 residential units comprising only 3 different designs in terms of size and same type of building material (reinforced concrete). It is evident that a small sample at these locations would be adequate to determine the mean and standard deviation of these structures.

A range of $8,000 to $11,000 was found as the standard deviation of structure values for the whole basin. Computation of a sample size using those numbers, and an acceptable error of $3,000 in the estimate, yield sample sizes that are always lower than the estimates using above procedure for a probability of 95 percent.

The sample applied for residential structure values, was also used to investigate residential contents. Average values and standard deviations are indicated in Table F-8.

TABLE F-8

RESULTS OF RESIDENTIAL SAMPLE SURVEY

	Structure Value		Content Value	
	Average	Std. Dev.	Average	Std. Dev.
REACH 1				
Coastal Area	24,500	4,600	7,800	2,800
Town South	36,200	9,700	9,500	3,000
Town Core	28,700	9,400	7,700	2,700
Town Periphery	32,400	10,700	8,700	2,900
REACH 2				
Coco Community	23,500	7,000	6,400	1,800

2. First floor elevation. The structure's elevation (first floor) above adjacent ground was measured for the surveyed sample. The mean value developed for every node was combined with the aerial topographic survey prepared for the study area (same used for the H&H analysis) to determine structure's depth of flooding. A standard deviation of 0.3 feet is associated to this type of surveying method.

3. Commercial land use. Assessed values were used for each commercial structure. There is a vast range of structure sizes for the same category of commercial business in Salinas. Mean structure values were computed based on information (pertaining to physical condition and age of structure) obtained from the field data supplied by occupants during the surveys, and valuations from local appraisers. A mean value of structure was estimated for each sector. A standard deviation was computed by grouping all commercial structures of the reach. A value of approximately five percent deviation from the mean was obtained for the standard deviation of commercial structure values.

As indicated in part III of this report, approximately 250 commercial establishments in the Río Nigua detailed study area are affected by the 100-year flood. These businesses were grouped into 6 categories. Refer to Table F-4. Average content values for each of the categories analyzed in this report were obtained from the total population, as indicated above. Analysis of content values for the same category of business (for which depth damage curves have been established), results in a standard deviation that departs approximately 20 percent from the mean value of the total universe of commercial establishments in Salinas.

4. Public and nonprofit facilities. The total population of the public and nonprofit facilities in the study area were surveyed. Mean structure values for these facilities are based on information obtained in the field, data supplied by the organizations, and valuations based on construction data from the Puerto Rico Permits and Regulations Administration. Standard deviations are based

on computations from the results of the survey. They are approximately 5 percent of the structure value. Averages and standard deviation values for contents were also computed based on the results of the field survey. The deviation obtained approximates 10 percent of the mean value for contents.

5. Industrial facilities. An industrial park consisting of 16 structures is located in the southern part of the urban sector. These buildings are owned by the Puerto Rico Industrial Development Company. The facilities are leased to the firms that are established in the park. Structure values for all of the facilities were provided by the government agency mentioned above. Average structure values and standard deviations were determined using the information provided.

The total of the industrial plants located at Salinas were surveyed for content value (inventory plus machinery and equipment) and depth damage relationships. Average contents value and standard deviations for this land use were computed utilizing the data provided by the industries involved. After all the firms were analyzed and depth-damage was established for each, an aggregate relationship for the contents of the entire industrial park was generated.

6. Simulation parameters. The following confidence interval and truncation limits were assigned to the inputs of the spreadsheets representing the two reaches in the flood plain for the simulation process. Truncation limits represent a minimum/maximum range for a random variable that may differ from the range indicated. These limits are needed to keep the model from calculating unrealistic values.

Confidence interval: ± 1.96 (95% degree of confidence)
Truncation limits

	Minimum	Maximum
Structure's First Floor Elevations (Standard Deviations)	-3	+3
Structure Value (Standard Deviations)	-3	+3
Contents/Structure Value	0%	2.5
Structure Depth-Damage	-10%	+10%
Content Depth-Damage	-10%	+10%

The truncation limits for the structure's first floor elevations and structure values were set at plus/minus 3 standard deviations. Limits of the content to structure value ratio ensures that the sampling process will not accept values of content for which its ratio with respect to any structure value drawn would be negative. Truncation limits set for the structure depth-damage percent presume that damage to the structure could range from -10 percent to +10 percent of the damage at any particular stage during the simulation process, assuming the structure would have some salvage value. Content depth-damage percent truncation limits were also set at ± 10 percent.

7. Number of iterations required. Sensitivity analysis was performed with 500, 1,000 and 1,500 interactions. Based on the compatibility of results, 1,000 iterations were selected for each simulation of the model. The number of simulations are established at 14 for Reach 1, and 15 for Reach 2.

C. Stage Damage Simulation Results

The combined mean damages and standard error of damages at different stages for the 6 categories of property analyzed are indicated in Table F-9 for Reach 1, and Table F-10 for Reach 2.

TABLE F-9

FLOOD DAMAGES ESTIMATES

WITHOUT PROJECT CONDITIONS

REACH 1

(Town and Coastal Area)

Stage (meters)	Mean Damage ($1,000)	SD of Error ($1,000)
1.04	0.10	0.20
1.65	0.40	0.40
2.26	423.00	89.40
2.56	4,921.20	522.20
2.87	11,129.70	914.00
3.02	16,179.50	1,143.00
3.17	21,821.00	1,347.80
3.32	28,329.00	1,548.60
3.48	34,422.00	1,665.00
3.78	42,357.70	1,925.50
4.09	49,011.70	2,211.70
4.70	57,526.10	2,706.50
5.61	60,946.20	2,959.60
6.83	60,946.40	2.959.60

TABLE F-10 FLOOD DAMAGES ESTIMATES WITHOUT PROJECT CONDITIONS REACH 2 (Coco Community)		
Existing Conditions		
Stage (meters)	Mean Damage ($1,000)	SD of Error ($1,000)
35.61	0	0
35.91	53.44	11.25
36.28	1,131.92	129.60
36.77	3,252.66	237.70
37.07	4,773.94	312.07
37.44	6,343.68	376.00
37.68	7,339.25	426.22
38.80	7,745.01	448.26
38.05	8,482.01	485.13
38.26	9,166.07	522.68
38.66	9,893.75	559.94
38.96	10,158.55	576.78
39.27	10,274.32	586.07
39.73	10,432.59	599.89
40.18	10,432.96	599.96

D. Other Categories of Benefits

In addition to the damage categories discussed under section IV-B above, other categories of benefits investigated included employment, advanced bridge replacement, agricultural, and flood insurance administrative costs saved.

These benefits, however, were analyzed after identifying the NED plan and were computed utilizing the traditional EAD methodology. Following is a description of each one of these benefits:

1. Employment benefit. The basis for considering employment benefit is contained in ER 1105-2-100 which is quoted in part. "Benefits from use of otherwise unemployed or underemployed labor resources may be recognized as a project benefit if the area has substantial and persistent unemployment at the time the plan is submitted for authorization and for appropriations to begin construction. Substantial and persistent unemployment exists in an area when: (1) the current rate of unemployment, as determined by the appropriate annual statistics for the most recent 12 consecutive months, is 6 percent or more and has averaged at least 6 percent for the qualifying time periods specified in subparagraph (2) below, and:

(2) The annual average rate of unemployment has been at least: (a) 50 percent above the national average for three of the preceding 4 calendar years, or (b) 75 percent above the national average for two of the preceding three calendar years, or (c) 100 percent above the national average for one of the preceding two calendar years."

Unemployment Statistics:

Year	Puerto Rico	U.S.A.	Percent Above National
1992	16.7	7.4	126
1993	17.1	6.8	151
1994	14.9	6.1	144
1995	13.7	5.6	145

Unemployment rate in Puerto Rico as of date of report: 14.6 percent

Unemployment rate at Salinas-Guayama-Patillas Labor Area for same period: 23.9 percent.

Tables F-11 and F-12 show the employment benefits for each one of the damage reaches.

TABLE F-11

EMPLOYMENT BENEFITS COMPUTATION - FOR REACH 1
(Town and Coastal Area)

Contract Construction & Mgt. Cost	$6,374,600			
Construction Period - Months	12			
Wages and salaries (20%)	$1,274,920			
Construction Schedule (%)	Month 3 30	Month 6 30	Month 9 20	Month 12 20
Wages and Salaries Per Period	382,476	382,476	254,984	254,984
Distribution by Category of Workers				
Skilled (60%)	229,486	229,486	152,990	152,990
Unskilled (10%)	38,248	38,248	25,498	25,498
Others (30%)	114,743	114,743	76,495	76,495
Wages to the Unemployed				
Skilled (20%)	45,897	45,897	30,598	30,598
Unskilled (80%)	30,598	30,598	20,399	20,399
Others (50%)	57,371	57,371	38,248	38,248
Subtotal (Benefit Claimed)	133,867	133,867	89,244	89,244
Worth of Benefit at End of Construction *	141,451	138,877	90,899	89,244
Total Benefit at End of Construction Period	460,471			
Equivalent Annual Benefit: #	$36,025			
Notes: * Annual Interest Rate = 7.625%				
# Amortized at I = 7.625% for 50 Years				

TABLE F-12 EMPLOYMENT BENEFITS COMPUTATION - FOR REACH 2 (Coco Community)				
CONTRACT CONSTRUCTION & MGT. COST	$2,392,200			
CONSTRUCTION PERIOD - MONTHS	12			
WAGES AND SALARIES (20%)	$ 478,440			
CONSTRUCTION SCHEDULE (%)	Month 3 30	Month 6 30	Month 9 20	Month 12 20
WAGES AND SALARIES PER PERIOD	143,532	143,532	95,688	95,688
DISTRIBUTION BY CATEGORY OF WORKERS				
SKILLED (60%)	86,119	86,119	57,413	57,413
UNSKILLED (10%)	14,353	14,353	9,569	9,569
OTHERS (30%)	43,060	43,060	43,060	43,060
WAGES TO THE UNEMPLOYED				
SKILLED (20%)	17,224	17,224	11,483	11,483
UNSKILLED (80%)	11,483	11,483	7,655	7,655
OTHERS (50%)	21,530	21,530	14,353	14,353
SUBTOTAL (BENEFIT CLAIMED)	50,236	50,236	33,491	33,491
WORTH OF BENEFIT AT END OF CONSTRUCTION *	53,083	52,116	34,112	33,491
TOTAL BENEFIT AT END OF CONSTRUCTION PERIOD	172,801			
EQUIVALENT ANNUAL BENEFIT: #	$13,519			
Notes: * Annual Interest Rate = 7.625%				
# Amortized at i = 7.625% for 50 years				

Total employment benefits claimed:

Reach 1	Reach 2	Total
$36,025	$13,519	$49,544

2. Advance bridge replacement benefit. If a railroad, highway, street, or pedestrian bridge is replaced as the result of a flood control project, a benefit can be claimed to at least partially offset the cost of replacing the bridge. Advance bridge replacement benefits are taken for the period that the useful life of the bridge is extended by the project. Table F-13 shows computation of the bridge replacement benefit.

TABLE F-13

ADVANCE BRIDGE REPLACEMENT BENEFITS COMPUTATION
($1,000 of November 1996)

Bridge Identification		
Location: Salinas		
River Intersected: Nigua		
Bridge No. 21		
Road No. PR1		
Year Built: 1939		
Last Evaluation: 1990		
Evaluation is according to FHA procedures. Indication is that the bridge will not be replaced in the near future.		
Benefit evaluation procedure in accordance with NED Procedures Manual Chapter 11, page 29.		
1	Cost of New Bridge	$827,100
2	Life of New Bridge	50
3	Remaining useful life of existing bridge at time of replacement	0
4	Extension of Bridge Life	50
5	Annual O&M of Existing Bridge	$ 1,000
6	Annual O&M of New Bridge	$ 1,000
7	Annual Interest Rate--Percent	7.625
8	Capital Recovery Factor (for 50 years)	0.078235
9	Annual Cost of New Bridge	$ 64,708
10	Present Worth of Annuity Factor for Extension of Bridge Life	12.7820
11	Present Worth of Benefit in Base Year, Credited to Bridge Life Extension	$827,000
12	Single Payment Present Worth Factor for Remaining Useful Life of Existing Bridge	1.00
13	Present Worth in Year 1 of Bridge Life Extension	$827,100
14	Annual O&M Savings Based on New Bridge O&M	$ ---
15	Present Wroth Annuity of Factor for Remaining Useful Life of Existing Bridge	$ ---
16	Present Worth in Year 1 of O&M Savings	$827,100
17	Present Worth of Total Credit	$827,100
18	Average Annual Benefit of New Bridge	$ 64,708

3. Reduction in flood insurance overhead. With a flood control project, the flood plain residents located in the protected area will no longer need flood insurance policies. It is appropriate to claim as a benefit the expense of servicing these policies and a pro-rata share of FIA's administrative costs. Table F-14 shows the computation process for the flood insurance costs saved, which are claimed as a benefit of the project.

Table F-14 shows the computation process for the flood insurance costs saved, which are claimed as a benefit of the project.

TABLE F-14

FLOOD INSURANCE BENEFITS COMPUTATIONS WITH PROJECT

The process consists of apportioning the total number of Flood Insurance Policies reported by FEMA Regional Offices for Puerto Rico to the total number of urban structures in Puerto Rico (we assume that structures outside of the urban zones are not insured) and, through a process of multiple correlation, determine the number of policies that would correspond to the study area.

Policies in force in Puerto Rico as of May 1995	25,260
Administrative cost per policy	115
Total number of housing units in urban areas in Puerto Rico	757,808
Assume five percent not at ground level	37,890
Number of housing units at ground level in Puerto Rico	719,918
Assume 30 percent additional urban structures other than residential	215,975
Total number of structures in urban areas in Puerto Rico	935,893
Ratio of Flood Insurance Policies to urban structures in Puerto Rico	0.02699
Number of urban housing units in Salinas 1995 (extrapolated from census data)	4,871
Less five percent assumed not at ground level	244
Number of housing units at ground level in Salinas	4,627
Add structures other than residential in urban area of Salinas (30%)	1.461
Number of urban structures in Salinas:	6,089
Total number of structures in the study area affected by flooding:	2,648
Total number of policies apportioned to the study area (2,648 x .02699)	71
Flood Insurance Administrative Costs saved (71 x 115)	$8,219

4. Agricultural damages. The agricultural damages considered in this analysis refer to losses attributed to flooding of crops and damage to the soil. At the present time the area in question is mostly occupied by sugar cane plantations, but is rapidly converting to vegetables and other cash crops. Conversations with P. R. Department of Agriculture Officials suggest that the acreage would be converted to harvesting of vegetables and other cash crops for which they have excellent incentive programs, both in the technical and also in the financial areas. Since 1980 over 20,000 acres of land converted from sugar cane to vegetables and other cash crops.

The following methodology was used to determine flood damages to agriculture. The crops specified below are a sample of those actually harvested in the Salinas-Santa Isabel valley. Data on crops, production costs, and profits, was provided the by P. R. Department of Agriculture (Products Statistics).

Production cost and profits assuming two crops per year is as follows:

Product	Cost/cda./year	Profit/cda./year
Green Peppers	3,675	1,580
Cucumbers	3,025	1,600
Dwarf Peppers	4,900	1,917
Cabbage	2,640	2,650
Egg-plant	3,210	2,800
Pumpkin	1,750	850

<u>Note</u>: cda. = cuerda = 0.97 acre

The production cost per major activity as percentage of total cost for the various stages in harvesting is as follows:

Land Preparation	Seed	Planting	Irrigation	Weed Removal	Harvesting	Total
13	13	34	10	10	20	100

Expected losses, as percentage of total production cost plus profit, at different stages during the production process is as follows:

	Percentage damage of particular activity			
Flood Elevation (feet)	Land Preparation	Planting	Growing	Harvesting
0.5	9	42	56	70
1.0	9	42	56	80
1.5	9	45	60	90
2.0	9	48	64	100
2.5	9	48	72	100
3.0	9	51	80	100
3.5	9	54	80	100
4.0	9	60	80	100

The duration of each activity for each production period is as follows:

Land Preparation	Planting	Growing	Harvesting
2 weeks	2 weeks	16 weeks	4 weeks

Percentage expected losses weighted by duration of each activity is shown below.

	Weighted percentage damage of particular activity				
Flood Elevation (feet)	Land Preparation	Planting	Growing	Harvesting	Combined (%) Expected Losses
0.5	0.75	3.5	37	12	53
1.0	0.75	3.5	37	13	54
1.5	0.75	3.8	40	15	60
2.0	0.75	4.0	43	16	64
2.5	0.75	4.0	48	16	69
3.0	0.75	4.3	53	16	74
3.5	0.75	4.5	53	16	74
4.0	0.75	5.0	53	16	75

The combined weighted percentage damage at different flood elevations provide the depth-damage relationship for agriculture.

The damage relationship together with water surface elevations at the area, as developed for the feasibility study, were used to estimate agricultural damages at three zones north of Playa de Salinas (the coastal zone). Table F-15 shown below indicates damage for each zone and for the three of them together by flood frequency.

TABLE F-15

AGRICULTURAL FLOOD DAMAGES ESTIMATES

Frequency	Depth of flooding			Damage Factor			Damage			Total
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Damage
2	0	0	0	0	0	0	0	0	0	0
5	0.26	0.26	0	0.480	0.480	0	157,222	134,708	0	291,930
10	1.25	1.25	0	0.552	0.552	0	180,805	154,305	0	335,110
25	2.43	2.43	0	0.570	0.570	0	186,701	159,337	0	346,037
50	2.95	2.95	0	0.570	0.570	0	186,701	159,337	0	346,037
100	3.48	3.48	0.66	0.570	0.570	0.538	186,701	159,337	80,345	426,382
SPF	4.00	4.00	1.31	0.570	0.570	0.558	186,701	159,337	83,332	429,369

ZONES	CROP HARVESTED
1. South of Industrial Park; East of Hwy PR 701	Egg Plant
2. Southeast of Zone 12	Dwarf Peppers
3. East of Zone 1	Green Peppers

Expected annual damages were estimated using the Corps of Engineers EAD Program Version of May 27, 1988. The expected annual damage is $113,250.

When computing agricultural benefits, they were assumed to be incidental to the extended levee plan protecting the town and the Playa area. The benefits will not accrue with the plan calling for a ring levee to protect the Playa area. Also, if sugar cane rather than cash crops have been assumed to be the predominant crop, it would not have altered the results of the cost effective analysis done to determine the best plan between the extended levee plan (protecting the town and playa area) and the plan calling for a levee for the town and a separate ring levee for the playa area.

E. Economics of the Risk-Based Recommended Plan

Several levee configurations and sizes were analyzed during the process of plan formulation and selection. A detailed discussion of the risk-based analysis (levee sizing process) is provided in the Main Report. The results of this procedure provide the plan that maximizes the NED benefits. The economics of that plan are shown on Table F-16.

TABLE F-16

ECONOMICS OF
THE RISK-BASED RECOMMENDED PLAN
($1,000 of August 1996)

Total First Cost		12,313.6
Interest During Construction		541.5
Total Investment Cost		12,855.1
Interest & Amortization		$1,005.7
Annual O&M Costs		66.0
TOTAL ANNUAL COST		1,071.7
Annualized Benefits		
Inundation Reduction	2,811.1	
Agricultural	113.3	
Employment	49.5	
Flood Insurance	8.2	
Advance Bridge Replacement	64.7	
TOTAL ANNUAL BENEFITS		$ 3,046.8
Net NED Benefits		$ 1,975.1
Benefits to Cost Ratio		2.8/1

*Benefits and Costs Amortized at 7.625%

*Period of Analysis = 50 years

*First cost does not include PL 91-646 assistance payments nor Cultural Resources Preservation

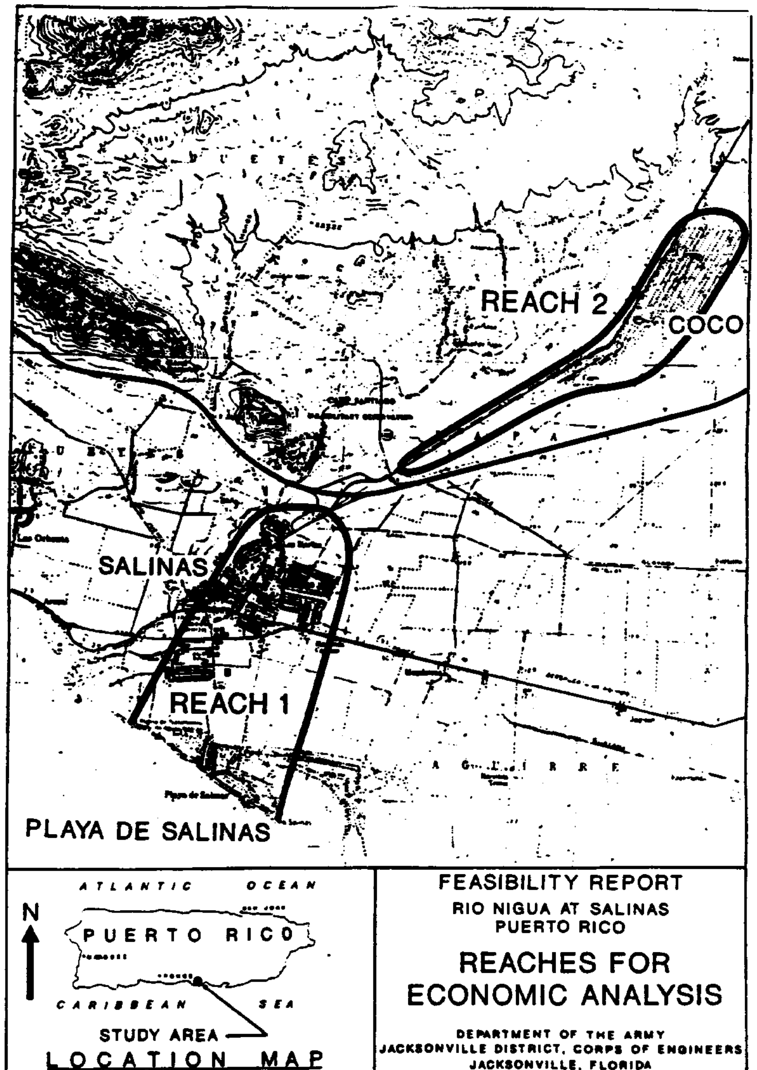

REACH 2
COCO
SALINAS
REACH 1
PLAYA DE SALINAS
ATLANTIC OCEAN
N
PUERTO RICO
CARIBBEAN SEA
STUDY AREA
LOCATION MAP
FEASIBILITY REPORT
RIO NIGUA AT SALINAS
PUERTO RICO
REACHES FOR
ECONOMIC ANALYSIS
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PLATE F-1